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Founded by J. A. Nieuwland, C.S.C.

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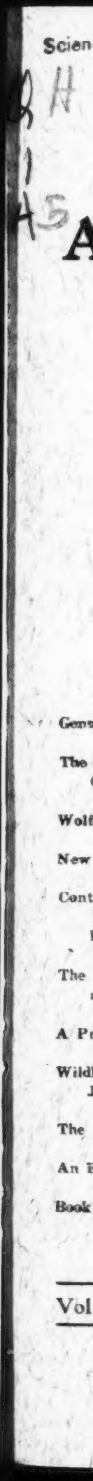
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John D. Mizelle, *Editor*

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Vol. 42 July, 1949 No. 1

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Authors are invited to submit carefully prepared manuscripts and requested to limit tables and illustrations as much as possible. Abstracts and reprint orders should accompany manuscripts or corrected proofs.

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The American Midland Naturalist

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The Genus Ruellia in Texas

B. C. Tharp

The University of Texas Herbarium,
Department of Botany and Bacteriology, Austin

Fred A. Barkley

Facultad de Agronomia,
Universidad Nacional de Colombia,
Medellin, Colombia, S. A.

The genus *Ruellia* of the Acanthaceae contains upward of two hundred species, a majority of which are tropical or near-tropical and, collectively, occur entirely around the earth. In the Western Hemisphere the genus extends from Pennsylvania to Wisconsin southwestward to Kansas, New Mexico, Arizona, California and Baja California; southeastward to Florida, the West Indies, Mexico, Central America and South America. In South America it extends into Paraguay and northern Argentina. This represents a range, in this hemisphere, from latitude 43° North (southern Wisconsin) to about latitude 25° South (northern Argentina). The geographic center of distribution in the western hemisphere would seem to lie in southern Mexico or in Central America. Assuming this to have been its region of origin in this hemisphere, a relatively uniform rate of spread would have brought about its present occurrence 15° to 18° farther north than south of the equator.

The genus appears to be absent in the Great Plains and Rocky Mountain regions of North America and along the Andean Mountains of Chile. In the tropics of both continents it extends to the Pacific Coast; but from southern California northward and from the Tropic of Capricorn southward, it seems not to do so.

Species of temperate regions, at least in North America, are usually herbaceous, with annual stems springing from short sub-ligneous perennial bases. The roots are typically numerous, fibrous and tough. In the tropics certain species become true shrubs and attain a height of 1 to 2.5 m. In extreme southern Texas the stems of certain species also occasionally become more or less shrubby.

Chasmogamous flowers[1] are typically showy, opening in the late afternoon or, usually, in early morning, and dropping by late morning or early after-

[1] Cleistogamy, except in *R. strepens* var. *cleistantha*, appears to be comparatively rare in group (1) below; in group (2) it is uniformly present as described in several of the species.

noon. Commonest color shades are bluish-lavender; but bright reds and yellows occurs, as does white.

Chasmogamous inflorescences follow one of two patterns: (1) axillary cymes along a simple axis, without a terminal panicle, and, in the United States, most abundant in the eastern portion; or (2) cymes compounded to form terminal panicles with no chasmogamous axillary cymes below, and restricted in the United States to the southwestern portion, whence it extends into adjacent Mexico. Fortunately for this study, Fernald's treatment of the eastern representatives of the former group (Rhodora 47: 1-37, 47-64, 69-90. 1945) made available an adequate analysis and framework into which its Texan representatives have, in the main, fitted quite satisfactorily. We have deemed it desirable to set up only two Texan varieties in this group. The latter (paniculate) group, however, has proven much more complicated and difficult. It comprises a complex centering about *Ruellia nudiflora* (Engelm. & Gray) Urban (Symb. Antill. 7: 382. 1912). First described by Engelmann and Gray (Bost. Jour. Nat. Hist. 5: 299. 1845.) as *Dipteracanthus nudiflorus,* it was later construed by Gray (Syn. Fl. N. A. 2: 325. 1886.) as belonging properly to *R. tuberosa* L., and so transferred. Urban (l.c.) concluded that the two were specifically distinct and restored the Engelmann and Gray species as *Ruellia nudiflora* (T. & G.) Urbs.[2]

A comparative study of our material has revealed that practically the only common points of similarity between members of otherwise dissimilar groups within the complex are the paniculate inflorescences and the herbaceous stems. Another point common to several of our proposed species is the production of peduncled cymes bearing only cleistogamous flowers which regularly occur in these species early in the season before the production of chasmogamous panicles. These are so inconspicuous as usually to escape notice; and their habit of early abscission renders them frequently absent on stems which bear mature, full flowering chasmogamous panicles. Most collections represent the latter condition and lack the axillary cleistogamous cymes. Not infrequently the terminal panicle will produce celistogamous flowers; and occasionally, apparently depending on growth conditions, these will be more abundant than the chasmogamous ones. Occasionally also the whole panicle of certain individuals produces only enlarged pedicels bearing flaring calices but no other flower parts. These definite abnormailties may be due to physiological causes, or possibly they are pathological. No assignable cause is apparent in the specimens. The group is attacked occasionally by a rust [*Puccinia ruellia* (B. & Br.) Lagerh.] but there seems to be no correlation between these attacks and the inflorence abnormalities.

Apparently little or no significance has heretofore been attached by investigators to the occurrence, within the paniculate group, of a great diversity in

2 We have not had the opportunity of examining any type material of *R. tuberosa* L., but have had on loan a single specimen from the Kansas State Agricultural College Herbarium, (*Rob. Combs* 224, June 20, 1895), from Cuba, which conforms to the description and which is, therefore, assumed to be correctly identified. It is abundantly distinct from *R. nudiflora.*

the shape and size of the corolla, and in the relative dimensions of the tube, throat and limb. So long as *R. nudiflora* remained a catch-all for all United States collections of paniculate forms, it was necessary to ignore these characters in order to assign to a single entity the diversity displayed by increasing numbers of dissimilar specimens.

More than twenty years ago this heterogeneity prompted Emery C. Leonard, of the United States National Museum to a study of the group which resulted in a revision (Jour. Wash. Acad. Sc. 17: 509-520. 1927.) setting up eight varieties of the species. His studies were apparently confined almost wholly to the material of the United States National Herbarium. Subsequently he annotated many sheets from other herbaria; but he has not undertaken further revision.

Attempts to fit the numerous collections at The University of Texas into Leonard's classification having proved unsatisfactory, and he (due to lack of time) having declined an invitation to study our material, the present authors felt impelled by necessity to attack the problem ourselves.

Accordingly, such collections from Texas and contiguous regions, including Mexico,[3] as were available in both the larger herbaria of the country and in smaller herbaria within Texas, were sought and obtained on loan. We wish to thank the directors and curators of such herbaria for their cordial generosity in making the loans and for their patient extension of time, necessitated by an unanticipatedly long period of study. These herbaria, together with their several citation abbreviations are as follows:

University of Arizona Herbarium	Ariz
Herbarium of Arnold Arboretum of Harvard University	Arnold
California Academy of Sciences Herbarium	CalA
The Herbarium of the University of California at Berkeley	Calif
L. Irby Davis Herbarium	Davis
The Herbarium of the Chicago Natural History Museum	Field
Gray Herbarium of Harvard University	Gray
The Herbarium of the Biological Institute of Mexico	IBM
The Herbarium of Iowa State College	Iowa
The Herbarium of the Kansas State College	KanSt
The Herbarium of the Missouri Botanical Garden	MBG
The Herbarium of the University of Nebraska	Nebr
The Herbarium of the New Mexico College of Agriculture	NM
The Herbarium of the New York Botanical Garden	NY
The Herbarium of the University of Oklahoma	Okla
The Herbarium of Jardin des Plantes, Paris	Paris
The Herbarium of the Philadelphia Academy of Sciences	Phila
The Rocky Mountain Herbarium at the University of Wyoming	RMt
The Robert Runyon Herbarium	Runyon
The Herbarium of the North Texas State Teacher's College	NTex
The Herbarium of the Southern Methodist University	SMU
The Herbarium of the University of Texas	Texas
The Tracy Herbarium at the Texas A. and M. College	Tracy
The National Herbarium at the United States National Museum	US

3 Mexican species which apparently do not extend into Texas; but which are closely allied with species that do, have been included in appropriate footnotes from the key.

We wish especially to thank Mr. Robert Runyon of Brownsville, longtime student of the vegetation of his area, and Mr. L. Irby Davis, of Harlingen, also interested in the flora of the lower Rio Grande region, for having made mass collections of troublesome entities during the course of this study.

A study of the wealth of material available to us, covering as it does the known range of all species which occur in Texas, has convinced us that diversity in vegetative, flowering and fruiting characters within what appear to us to be valid specific entities, are much more restricted and definite than has been heretofore assumed. Accordingly, they have been used as a basis for defining such entities.

It has interested us to find that our specific entities thus determined fall, in general, each into a coherent geographic distributional pattern; not, however, without an occasional disjunct occurrence.

With one exception[4] all Leonard's varieties,[5] insofar as they come within the geographic range covered by our studies, have been elevated to specific rank. Entities which he even failed to note have seemed worthy of specific rank and are here treated as species. It remains for future monographers to review our work and sustain or reject our conclusions.

An apparently promising approach to further investigations would seem to be the use of cytotaxonomic methods. The genus seems to offer almost ideal material for such studies. The perennial habit of all species should enable the investigator to maintain his parent stocks while observing the behavior of offspring; the large size of flowers should facilitate artificial cross-pollination; and meiotic material should not be difficult to obtain and examine.

List of persons in honor of whom new species and varieties are named in this paper:

Edward Palmer, who spent much of the last quarter of last century collecting in Mexico: S2. *Ruellia Palmeri.*

Mary Taylor (Mueller) Edwards, a former graduate student at The University of Texas, who has worked on the vegetation of a portion of the state of Nuevo Leon, Mexico: S3. *Ruellia Edwardsae.*

Forrest Shreve, well known veteran student of desert vegetation. Desert Laboratory, Tucson, Arizona: S4a. *Ruellia glabrata* var. *Shreveі.*

Sister Mary Clare Metz, Professor of Botany, Our Lady of the Lake College, San Antonio, Texas: 1. *Ruellia Metzae.*

Ernest G. Marsh, Jr., who has done extensive collecting in western Texas and adjacent Mexico. He is presently Assistant Director of Wild Life Restoration for the Texas Game, Fish and Oyster Commission. 1a. *Ruellia Metzae* var. *Marshii.*

Cornelius H. Mueller,[6] a graduate of The University of Texas and student of the

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4 *R. nudiflora* var. *grandiflora* Leonard, Wash. Acad. Sci. 17: 516. 1927, is here assigned as a variety of *R. Mulleri* Tharp and Barkley.

5 In addition to the species and varieties treated in this study, a species from the West Indies, similar to *Ruellia yucatana,* (of which only the type: *Eggers* 5452 in the U. S. Nat. Herb., has been studied by the authors) must be excluded from the species as: *Ruellia insularis* (Leonard) Tharp and Barkley, comb. nov. (*Ruellia nudiflora* var. *insularis* Leonard, Wash. Sci. 17: 519. 1927.).

6 Spelling of the name using the umlaut (ue) conforms to that on the herbarium sheets. Dr. Muller subsequently dropped the umlaut.

flora, especially the oaks, of Texas, Mexico and Central America. He is presently with Santa Barbara College, California. 2. *Ruellia Muelleri.*

Cyrus L. and Mrs. A. A. Lundell, who collected the type specimen, the only specimen representing this variety among those embodied in this study. 3a. *Ruellia occidentalis* var. *Lundelliorum.*

Charles Wright, pioneer botanist attached to the United States-Mexican Boundary Commission: 3b. *Ruellia occidentalis* var. *Wrightii.*

Roxana Ferris, Assistant Curator of the Dudley Herbarium of Stanford University: 3c. *Ruellia occidentalis* var. *Ferrisae.*

L. Irby Davis and Anna Tarrence Davis of Harlingen, Texas, friends, who through mass collections have given valuable assistance in the course of these studies: 5. *Ruellia Davisiorum.*

S. G. Drushel of Edna, Texas, friend and long-time student of Texas vegetation: 7. *Ruellia Drushelii.*

Faustino Miranda, of the Herbario Nacional de Mexico, in the Instituto de Biologia de Mexico who has extended courteous assistance to the junior author in his studies of the flora of Mexico: 8a. *Ruellia nudiflora* var. *Mirandae.*

Antonio Hernandez Corzo, of the Instituto Politecnico de Mexico, who has rendered generous and valuable aid to the junior author in his studies in Mexico: 9. *Ruellia Corzoi.*

Robert Runyon of Brownsville, Texas, a friend and for many years a student of the vegetation of the Lower Rio Grande Valley and the best living authority on it: 10. *Ruellia Runyonii.*

Jean Louis Berlandier, the first botanist to make extensive collections in Texas: 10a. *Ruellia Runyonii* var. *Berlandieri.*

KEY TO THE SPECIES

A Plants bearing a terminal panicle of flowers, in addition to which there are usually lateral, few-flowered panicles of cleistogamous flowers produced early. Often all traces of these has disappeared before the expanded flowers appear.

B Corolla 5 cm. long or more.

C Plants low (10 to rarely 20 cm. tall), densely long white hirsute (at least at first); terminal inflorescences short and compact; leaves thick, ovate, subacute at apex, decurrent on the petioles, 2.5-6 cm. long, 1-2 cm. wid .....1a. *R. Metzae* var. *Marshii*

C Plants tall (rarely under 20 cm. except in some *R. Metzae*), never conspicuously white hirsute.

D Leaves lanceolate or lanceolate-ovate; leaves and stems shortly and sparsely hirsute.

E Corolla white; tube rarely shorter than 3 cm., longer than the throat.

F Leaves spatulate-oblanceolate or narrowly ovate, rounded at the apex or rarely subacute, cuneate at the base, undulate margnied, 1-3 cm. broad, 3.5-14.5 cm. long .....1. *R. Metzae*

F Leaves lanceolate, acute at apex, cuneate at base, repand-undulate, 1.5 3 cm. broad, 6-12.5 cm. long .....2. *R. Muelleri*

E Corolla lavender or pale lavender.

F Tube 2.5-3 cm. long, longer than the throat .....2a. *R. Muelleri* var. *grandiflora*

F Tube rarely exceeding 2 cm., shorter than the throat .....8. *R. nudiflora*

D Leaves ovate; leaves and stems velvety-pilose at least at first, and often somewhat viscid; corolla bluish-lavender.

E Inflorescences an ample terminal panicle.

F Leaves 4-6 cm. broad, 7.5-12 cm. long .....3. *R. occidentalis*

F Leaves very large, 6-9.5 cm. broad, 14.5-19 cm. long .....3a. *R. occidentalis* var. *Lundelliorum*

E Inflorescence a compact or spikelike terminal panicle.

F Leaves large, 2-5 cm. broad, 8-13 cm. long, corolla about 5 cm. long.

G Leaves obtuse; panicle branches robust, calyx with subulate tips, stems herbaceous .....3b. *R. occidentalis* var. *Wrightii*

G Leaves acute; panicle branches slender, calyx with filiform tips; stems ligneous at the base .....4. *R. strictopaniculata*

F Leaves small, 2-3 cm. broad, 5-6 cm. long; stems herbaceous to subligneous, corolla 5-6 cm. long .....5. *Davisiorum*

B Corolla less than 5 cm. long (where known[7]).

C Inflorescence mostly conspicuously bracted, elaborate axillary panicles with terminal panicles small or absent; corolla about 2.5 cm. long; plant subshrubbery, branches suberect or ascending from decumbent rooting bases; leaves broadly lanecolate and acute at apex; plant viscid-pubescent throughout at first .....6. *R. paniculata*

C Inflorescences not conspicuously bracted, mostly terminal; if corolla less than 3 cm. long then the plants very low; plants herbaceous if low.

D Corolla over 4 cm. long.

E Plants conspicuously long white hirsute; exclusive of the inflorescence very low (not exceeding 10 cm.); elongated internodes 1-2 (rarely 3); lateral panicles often producing chasmogamous flowers.

F Leaves lanceolate-ovate, 1-1.5 cm. broad, 2.5-5 cm. long; fruit not exceeding 1.5 cm. in length .....7. *R. Drushelii*

F Leaves lanceolate-ovate to ovate, 1.5-3.5 cm. broad, 4-11 cm. long; terminal panicle well developed, 3-25 cm. long; fruit about 2 cm. long .....7a. *R. Drushelii* var. *macrocarpa*

E Plants not conspicuously long white hirsute; stems with several leaf-bearing nodes; plants tall, usually 25 cm. or more; lateral panicles rarely producing chasmogamous flowers.

F Plant not finely or velvety pilose, but often sparsely and obscurely pilose.

G Leaf blades ovate to broadly ovate .....3c. *R. occidentalis* var. *Ferrisae*

G Leaf blades oblong to narrowly oblong-ovate .....8. *R. nudiflora*

F Plant finely and velvety pilose .....8a. *R. nudiflora* var. *Mirandae*

D Corolla 4 cm. or less long.

E Leaves lanceolate or lanceolate-ovate.[8]

F Leaves and stems (at least at first) conspicuously long white-pilose; leaves spatulate to lanceolate, rounded or rarely subacute at apex; corolla 3 cm. long .....9. *R. Corzoi*

F Leaves and stems not long white-pilose; leaves lanceolate-ovate acute or subacute at apex; corolla 3.5-5 cm. long.[9]

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7 The Mexican species *R. congesta* differs from the other species of this group in that it has a compact terminal panicle usually not producing chasmogamous flowers, but sterile and cleistogamous flowers, the leaf bearing nodes are few, the plants are low, about 25 to 30 cm tall, the leaves are spatulte to obovate, 1.5-4 cm broad and 4.5-11 cm. long. The other species usually produce at least some expanded corollas.

8 *Ruellia Corzoi, R. Runyonii,* and *R. Edwardsae* have stems with several leaf-bearing nodes, while the Mexican species *R. Palmeri* has only 2 or 3 leaf-bearing nodes.

9 The Mexican species *Ruellia Edwardsae* has leaves velvety-hirsute; the panicle is dense and the corollas are about 3.5 cm. long, while in *R. Runyonii* and its variety the corollas are usually 4 cm. long, the panicle elaborate and the plant is not velvety-hirsute.

G Stems and leaves very sparsely and very obscurely hirsute; corollas about 4 cm. long ..... 10. *R. Runyoni*

G Stems and leaves densely pilosulous but not velvety; corollas 3.5-4 cm. long ..... 10a. *R. Runyonii* var. *Berlandieri*

E Leaves ovate, stems usually with few leaf-bearing nodes near the base; horizontal-ascending basal cleistogamous cymes; basal leaves prominent, mostly broadly rounded at the base[10] ..... 11. *R. yucatana*

A Inflorescences in axillary, sessile or more or less peduncled glomerules or cymes; bracts foliaceous.

B Main axis terminating in a flowerless leafy tip; flowers 1 to few at leafy bracted summits of branches or on peduncles from the median or lower axils, or the cymose inflorescence much branched; if with sessile or short pedicellate solitary flowers in the axils, flowers less than 5 cm. long.

C Bracts of the loose cyme linear or linear-lanceolate.

D Leaves chiefly elongate-linear ..... 12. *R. Brittoniana*

D Leaves chiefly lanceolate ..... 13. *R. malacosperma*

C Bracts dilated; leaves lanceolate, oblong, elliptic or ovate.

D Stems low (1-10 cm. tall) from a lignescent base, or if taller then shrubby; plants of the Trans-Pecos region ..... 14. *R. Parryi*

D Stems taller, not fruticose[11]; plants not extending westward beyond central Texas.

E Calyx lobes narrowly linear (1-1.2 mm. broad) with prolonged linear-acicular tips.

F Ovary pubescent with short spreading hairs; calyx pilose with slender pointed hairs; leaves short petioled ..... 15. *R. pedunculata*

F Ovary glabrous; calyx closely covered with appressed and partially immersed slender cystoliths; leaves subsessile ..... 16. *R. pinetorum*

E Calyx-lobes lanceolate to linear-lanceolate, 2-4 mm. broad, flat to the tip; ovary and capsule glabrous; leaves petioled ..... 17. *R. strepens*

B Main axis bearing flowers in sessile or short peduncled glomerules, or if flowers borne singly in axils, the corolla 5-11 cm. long.

C Calyx-lobes linear-lanceolate, 2-4 mm. wide, flat to the tips; flowers chiefly or wholly cleistogamous ..... 17a. *R. strepens* var. *cleistantha*

C Calyx-lobes narrowly linear, the prolonged tips very slender to almost bristle-form; flowers rarely celistogamous.

D Principal leaves spatulate-oblong or spatulate-obovate, the plant appearing rosulate, or the main axis expanded and bearing lanceolate and subacute to obtuse leaves; leaves and stems often white-villous at least in part ..... 18. *R. ciliosa*

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10 *Ruellia yucatana* has prominent basal horizontal-ascending cleistogamous cymes, the leaves mostly broadly rounded at the apex and occurs from Texas to Yucatan, while the very distinctive *R. glabrata* of Arizona and adjacent Mexico has mostly inconspicuous caulescent sharply-asecnding cleistogamous cymes and the leaves are mostly narrowed toward the apices which are rounded-subacute. The variety *R. glabrata Shrevei* is a shorter stockier plant than the species.

11 There are two Mexican-Central American species similar in some respects to *Ruellia pedunculata*. They may be separated as follows:

A Leaves spatulate or oblanceolate and decurrent on the petioles; flowers borne on short peduncles; ovary pubescent ..... S5. *R. puberula*

A Leaves orbicular, long decurrent on the petioles; flowers borne on long peduncles; ovary glabrous ..... S6. *R. intermedia*

D Principal leaves not spatulate-oblong or spatulate-obovate, the plants not rosulate; stems and leaves rarely white-villous except in the bud.

E Corolla 7-11 cm. long; expanding in the evening .....19. *R. noctiflora*

E Corolla 3-7 cm. long (longer in some specimens of 20c and 20d), expanding in early morning.

F Leaves essentially sessile, ascending-erect.

G Stems filiform, mostly less than 2 mm. thick at base, branches usually decumbent at base and strongly ascending glabrescent to sparsely pilose; flowers 4-7 cm. long; leaves thin, spatulate, oblanceolate or lanceolate, puberulent, sparsely pubescent to sparsely pilose, usually not crowded on the stems .....20a. *R. humilis* var. *depauperata*

G Stems stout; leaves lanceolate to suborbicular, mostly crowded on the stems; branches suberect to strongly divergent, typically villous-hirsute.

H Corolla 3-4.5 cm. long, its slender tube 1.2-2.5 cm. long.

I Larger leaves of main axis elliptic-oblong or oblong-lanceolate, 1-2.5 cm. broad, obtuse to subacute .....20. *R. humilis*

I Larger leaves of main ovate to oval-oblong or broadly elliptic, 2-4 cm. broad, mostly rounded at summit; stems strongly spreading, villous .....20b. *R. humilis* var. *frondosa*

H Corolla usually 5-8 cm. long, its slender tube 3-5 cm. long.

I Larger leaves of main axis elliptic-oblong to oblong-lanceolate, 1-2.5 cm. broad, obtuse to subacute .....20c. *R. humilis* var. *longiflora*

I Larger leaves of main axis ovate-oblong to broadly oval, rounded at summit, 2.5-4 cm. broad .....20d. *R. humilis* var. *expansa*

F Leaves distinctly petioled, spreading.

G Glomerules few, restricted to the upper internodes; leaves lanceolate.

H Corolla 2.5-5 cm. long; stem mostly strongly divergent-branched from the lower and median axils .....21a. *R. carolinensis* var. *semicalva*

H Corolla 2.5-4 cm. long; stem mostly simple or with few ascending branches .....21b. *R. carolinensis* var. *salicina*

G Glomerules several to many, extending well downward on the stem or branches.

H Leaves relatively narrow, dentate; linear to lanceolate; internodes at least twice as long as the leaves .....21c. *R. carolinensis* var. *serrulata*

H Leaves relatively broad, entire to undulate, ovate to broadly elliptic; internodes not much exceeding the leaves .....22. *R. Drummondiana*

S1 **Ruellia congesta** (Leonard) Tharp and Barkley, COMB. NOV.

Ruellia nudiflora var. *congesta* Leonard, Jour. Wash. Acad. Sci. 17: 518. 1947.

Roots tough, coarse-fibrous; stems herbaceous, up to 25 cm. tall, erect, more or less branched with 2-3 elongated internodes, terete near base, 4-angled and manifestly grooved above, densely puberulent, hirsute at the nodes, glandular-pilsoulous and somewhat viscid in the inflorescence; leaf-blades elliptic-oblong,

5-10 cm. long, 2-4 cm. broad, obtuse, about equally green on both surfaces, moderately thickened, sparsely hirsutulous above and beneath, the margins undulate, slightly crisped, acuminate-decurrent on petioles up to 15 mm. long; cleistogamous leafless cymes singly disposed at the lower nodes (often opposite a foliar branch), usually 1-3-flowered; principal inflorescence a congested panicle, most of whose flowers consist of only a calyx on an elongated pedicel (fertile chasmogamous flowers absent on specimens available); peduncles of terminal panicle 65 mm. long or almost wanting, sterile pedicels 1-3.5 cm. long, their calyx-lobes narrowly linear, green, densely glandular-pilosulous and

Fig. 1.—*Ruellia congesta* (Leonard) Tharp and Barkley. Type.

Fig. 2.—*Ruellia Palmeri* Tharp and Barkley. Type.

somewhat viscid; cleistogamous calyx-lobes in fruit 9-12 mm. long, broader than the sterile and less glandular-pilosulous, the capsules 10-12 mm. long, 3-3.5 mm. thick, thickest at or above the middle, finely retrorse puberulent; chasmogamous fruit (a single apparently immature capsule) about 14 mm. long, 2 mm. thick, nearly cylindric, more densely pilose and glandular, especially near the apex; seeds (of cleistogamous fruits) 3-4 in each cavity, orbicular, cinnamon brown, 2.5 mm. in diameter.

Type.—Vicinity of San Luis Potosí, 1877, *Schaffner* 398 in the U. S. National Herbarium 938568. (The above description drawn from *Schaffner* 73 in the Gray Herbarium since it is a more complete specimen than the type.)

Distribution.—Known only from San Luis Potosí.

Specimens examined.—SAN LUIS POTOSI: *Schaffner* 398 (US), G. Paludosis prope Morales, August 1876, 73 (Gray).

S2 **Ruellia Palmeri*** Tharp and Barkley, SP. NOV.

Herbacea perennis; caule brevi, 20 cm. alto; foliis lanceolatis vel late lanceolatis, plus minusve subacutis, 3-5 cm. longis, 15-20 mm. latis, plus minusve puberulentis et hirsutulis; inflorescentii brevibus, dense glandularibus; floribus plus minusve sessilibus; corollis purpureis, circa 3.5 cm. longis; capsulis 1.5 cm. longis, puberulentis.

Roots clustered, very slender-fusiform, from a very short ligneous perennial stem-base; stems erect, short (20 cm. tall or less), relatively stout, with usually 2-3 elongated internodes, densely puberulent and also manifestly hirsute becoming glandular above; branches arising singly from each leaf-axil, ascending, similar in all respects to the stems except (slightly) shorter; leaves with blades lanceolate to broadly so (occasionally the lowermost broadly elliptic), apically acute to subacute, basally acuminate-decurrent, 3-5 cm. long, 15-20 mm. broad, more or less puberulent and hirsutulous especially on the veins beneath, the petioles (except the uppermost) manifest, occasionally 2 cm. long, usually 1.5 cm. or less; inflorescence of usually 2 glomerules separated by the ultimate internode, sometimes reduced to a single terminal glomerule, peduncles and pedicels both substantially wanting, pubescence densely glandular-hirsutulous; calyx lobes at anthesis about 10-12 mm. long, subulate, rather uniformly green without manifest mid- or marginal nerves, densely hirsutulous with stiff white spreading glandular slightly viscid hairs; corollas mostly chasmogamous (only occasional ones are cleistogamous), about 3.5 cm. long, the tube 8-9 mm., throat 15 mm., narrowly campanulate, abruptly contracted into tube, lobes 10-12 mm. long, (described by Palmer as purple); longer filaments 11-12 mm. long, shorter ones about 4 mm., anthers 3 mm. long; style about 2 cm. long, stigma 1.5 mm. long, half as broad, concave, the short lobe scarcely manifest; capsule 15 mm. long, 4 mm. thick, broadest above the middle, densely retrorse-puberulent below, spreading glandular-pubescent at and below the apex.

Type.—Saltillo, Coahuila, Mexico, May 1898, *Edward Palmer* 159 in the Herbarium of the University of California 102652.

Distribution.—Near Saltillo, Coahuila, Mexico.

* See page 4.

Specimens examined.—COAHUILA: vicinity of Saltillo, April 1880, *Palmer s. n.* (Gray), near Saltillo, 158 (MBG) and Saltillo, May 1898, 159 (Calif. Gray, NY, US).

The fruiting specimens on the Gray Herbarium sheet and on the National Herbarium sheet (336155) apparently had cleistogamous flowers only.

S3 **Ruellia Edwardsae*** Tharp and Barkley, SP. NOV.

Herbacea perennis caulescens, circa 2 dm. alta, dense pilosula; foliis ovato-lanceolatis, subcoriaceis, obtusis, cuneatis, plus minusve crispis undulato-ser-

* See page 4.

Fig. 3.—*Ruellia Edwardsae* Tharp and Barkley. Type.

ratisque, 2-4.5 cm. longis, 1.4-2 cm. latis, dense pilosulis, paniculis terminalibus condensatis; corollis 3.5-4.5 cm. longis.

Plant perennial, herbaceous or often subligneous at the base, 18-20 cm. tall, nodes 2-3 cm. long, often with a single leafy branch from one or more of the lower-most nodes, branches ascending, celistogamous flowering branches often opposite leafy branches, basal internodes subterete, densely pilosulous, with fine obscure cystoliths, upper internodes obtusely quadrangular and grooved between the angles, very densely eglandular-pilosulous up to the inflorescence; leaves ovate-lanceolate to narrowly ovate, basally narrowed and decurrent on short (2-5 mm. long) petioles, blades distinctly thickish, margin more or less crisped, finely undulate-serrate, apex rounded to obtusely angled, 2-4.5 cm. long, 1.4 to 2 cm. broad, scarcely reduced above, velvety pilosulous beneath, less so above; inflorescence a congested terminal panicle; pedunculate lateral cymes of one to usually three cleistogamous flowers in the axils of most of the lower leaves; cleistogamous flowers with calyx 7-8 mm. long sparsely eglandular, densely hirsutulous, lobes subulate, .5 mm. broad at base, 7-8 mm. long, not viscid, corolla 4 mm. long, 1.5 mm. thick; chasmogamous flowers deep blue-purple, the calyx at anthesis united for 1-1.5 mm. at base, lobes 12-13 mm. long, 1 mm. broad at base, attenuate-subulate, densely hirsutulous-glandular, non-viscid, corolla 3.5-4 cm. broad, lobes about 1 cm. long and broad, broadly rounded, tube and throat finely puberulent especially so on veins, tube abruptly expanded into the throat, style 18-20 mm. long.

This species is known only from the type collection: NUEVO LEON: "Frijol," Rancho Resendez, Lampazos, 24 June 1937, *Mary Taylor Edwards* 329 in the University of Texas Herbarium.

S4 **Ruellia glabrata** (Leonard) Tharp and Barkley, COMB. NOV.

Ruellia nudiflora var. *glabrata* Leonard, Jour. Wash. Acad. Sci. 17: 518. 1927.
R. tuberosa occidentalis A. Gray, Syn. Fl. 2: 325. 1878, in part.

Stems up to 5 dm. tall, herbaceous from a subligneous fibrous-rooted base, more or less branched throughout or sub-simple below, basally subterete, becoming manifestly 4-angled and grooved upward, more or less hirsute below, glabrate toward the middle, densely glandular-hirsutulous terminally, internodes 3-4 below the panicle; leaves with blades broadly ovate to narrowly ovate-lanceolate, obtuse to acutish, thin to relatively thickish, prominently veined, 6-18 cm. long, 2.5-9 cm. broad, prominently decurrent on the manifest petioles (up to 4 cm. long), the lower surface usually paler than the upper, hispidulous (frequently only on the nerves) beneath, more densely so above, the margins coarsely crenate-undulate, slightly crisped; cleistogamous-flowered cymes frequently arising (usually singly) from one or more of the lower, middle, or upper nodes, usually 3-flowered, sometimes with more or fewer flowers, the calyx lobes at pollination 6-8 mm. long, white, pilosulous, many of the hairs tipped with yellow-brown, non-viscid glands without, glabrous, green, and uninerved within, about .6 mm. broad at base, linear-lanceolate, subulate, corolla 2.1-4.5 mm. long, slightly or not at all constricted above the somewhat (or

sometimes not) swollen base, the lobes very finely-puberulent; filaments .8-1 mm. long, ovary 1-2 mm. long, scarcely 1 mm. broad, densely minute-puberulent; ovules 4-6 in each cavity, style 1 mm. long, curved, basally conic, stigma narrowly deltoid, uncinately recurved, the short lobe obsolete; chasmogamous flowers purplish-blue in ample panicles of divaricate-ascending, forking cymes

Fig. 4.—*Ruellia glabrata* (Leonard) Tharp and Barkley.

whose ultimate branches bear each a subsessile central flower and two lateral peduncled ones, the whole panicle up to 2 dm. long, increasingly glandular-pilose with pale to yellow-brown glands; calyx at anthesis 10-17 mm. long, the lobes linear, .5 mm. broad at base, green, obscurely 1-nerved, glandular-pilosulous without like the pedicels, eglandular-hispidulous within, the corolla 3.5-4.5 cm. long, rather densely very finely glandular-puberulent, the tube 10-15 mm. long, 1.5-2 mm. thick, rather strongly ridged, the throat 15-18 mm. long, 13-15 mm. broad at lobe-bases, the lobes 8-10 (-13) mm. broad, about equally long, rounded to retuse at apex, the margins undulate; longer filaments 8-9 mm. long, the shorter 5-6 mm., anthers oblong, 2-2.5 mm. long, .5 mm. broad, the basal lobes about .8 mm. long; styles 2.5-3 cm. long, stigmas 1.5 mm. long, .2-.3 mm. broad, the short lobe obsolete; cleistogamous fruits clavate, 12-14 mm. long, slightly shorter than or equalling the fruiting calyx, 4 mm. thick, thickest at or above the middle, finely retrorsely puberulent on lower portion, becoming spreadingly so and increasing glandular toward the apex, retinacula rather strongly curved, brown at base, almost white at apex, about 2 mm. long; seeds orbicular, 3 mm. in diameter; chasmogamous fruits 15-22 mm. long, shorter than to about equalling the fruiting calyx-lobes, 4-6 mm. thick, broadly clavate, puberulence as in cleistogamous fruits, seeds about 3.5 mm. long, almost as broad.

Type.—Ciènega, Arizona, Aug. 1874, *J. T. Rothrock* 560 in the Gray Herbarium of Harvard University.

Distribution.—southern Arizona and Sonora.

Specimens examined.—ARIZONA: cultivated field near Fort Lowell, 15 September 1900, *Griffiths* 1584 (NY); southern Arizona, 1867, *Palmer* 166 (MBG); Ciènaga, 1874 *Rothrock s. n.* (NY) and 560 (Gray, Phila); PIMA CO.: Tucson, 1888, *Aguirre s. n.* (Ariz); Picture Rocks, Tucson Mountains 21 January 1920, *Bartram* 396 (Phila); end of old Anklam road, 5 November 1931, *Carter* 5848 (Ariz); under mesquites, Vamori School west of Topawa, 17 October 1945, *Goodding* 194-45 (Ariz); weedy perennial in roadside ditch six miles south of Tucson on Nogales Road, alt. 2500 ft., 5 October 1944, *Gould* 2645 (Ariz); in openings in mesquite bosque, heavy clay soil, 1.5 miles west of Tracy's Store, Quijotoa Valley, alt. 2000 ft., 29 August 1945, *Gould and Haskell* 3210 (Ariz) and abundant along sandy wash two miles southeast of Walls Well near northern end of Ajo Mountains, 30 August 1945, 3215); Babiroquivra Mountains, 19 September 1929, *Jones* 25001 (CalA, NY); Babiroquivra Mountains, 30 September 1934, *Kearney and Peebles* 10391 (CalA); irrigation ditch bank, Tucson, 28 November 1936, *McDowell s. n.* (Ariz; Santa Cruz valley near Tucson, May and June 1881, *Pringle s. n.* (Gray, NY); Tucson, alt. 2500 ft., August 1916, *Shreve* 4933 (Ariz); Santa Cruz flood plains, Tucson, July 1916, *Swingle* S302 (Ariz); 4 miles northwest of Tucson, 23 August 1901, *Thornber s. n.* (Ariz, Texas), in swales of mesas, Tucson, August 1903, 5263 (Ariz), elev. 2350 ft., Tucson, 2 September 1903, 55 (Ariz, Nebr, NY, Texas), mesas, Tucson, September 1910, 5740 (Ariz); Tucson, 30 April 1892, *Toumey* 176 (4888) (Ariz); SANTA CRUZ CO.: Agua Caliente, Santa Rita Mountains, 8-10 September 1910, *Pilsbry s. n.* (Phila).

MEXICO: San Bernadino Ranch, on the Boundary Line, 20 August 1892, *Mearns* 737 (Gray, MBG, NY).

SONORA: wet soil along arroyo Bacum Station near Rio Yaqui, alt. 30-40 meters, 7 September 1935, *Pennell* 20202 (Phila); in shade of bushes, Bahio de Aquituni between Pitiquite and Rancho Verruga, Desto. de Altar, 23 October 1932, *Shreve* 6023 (Ariz); Canyon de las Bellotas, 29 August 1940, *White* 3565 (Ariz).

Fig. 5.—*Ruellia glabrata* (Leonard) Tharp and Barkley var. *Shrevei* Tharp and Barkley. Type.

S4a **Ruellia glabrata** var. **Shrevei*** Tharp and Barkley, VAR. NOV.

Herbacea perennis; caule circa 2.5 dm. alto; foliis ovatis vel anguste ovatis, 3-9 cm. longis, 1.5-4.5 cm. latis, subacutis, hirsutulis, subintegris vel undulato-dentatis, plus minusve crispis; inflorescentibus terminalis, viscidibus; corollis 3-4 cm. longis.

Stems 2.5 dm. tall or less, from distinctly slender-fusiform-rooted subligneous base, mostly both hirsute and finely puberulent throughout, becoming densely glandular and more or less viscid in the inflorescence, the number of internodes 3-4; leaves with blades ovate to narrowly elliptic-ovate, 3-9 cm. long by 1.5-4.5 cm. broad, abruptly to gradually acuminate-winged on petioles 2 cm. long or less, apically rounded to subacute, prominently veined, distinctly hirsutulous on both surfaces, the margins sub-entire to shallowly undulate-dentate, more or less crisped; cleistogamous-flowered cymes as in *R. glabrata*, the calyx-lobes 6-7 mm. long at pollination, subulate, densely hirsutulous, viscid-glandular with white to yellowish-brown glands, obscurely uninerved; corolla 3-4.5 mm. long, more or less swollen just above the base; chasmogamous flowers in ample or narrowly congested panicles 1 dm. long or less, with an admixture of cleistogamous ones, densely pilosulous-glandular, the glands pale to yellowish-brown, the calyx at anthesis 16 mm. long or less, the lobes linear-subulate, .7 mm. broad at base, green, obscurely nerved, densely hirsutulous-glandular with yellowish-brown glands; corolla purplish-blue, similar to that of *R. glabrata* but somewhat smaller (3-4 cm. long), the style 15-17 mm. long, stigma 15 mm. long, linear-ligulate, the short lobe obscure; fruits from cleistogamous flowers 13-15 mm. long, 3.5 mm. thick, thickest near the middle, tapering at both ends, densely puberulent, the upper portion glandular, as long as or slightly exceeding the fruiting calyx; retinacula and seeds as in *R. glabrata;* fruits from chasmogamous flowers immature in material available.

Type.—in open shrubbery, Yerbanis, 6200 ft. alt., 24 August 1939, *Forrest Shreve* 9128 in the University of Arizona Herbarium 30733.

Distribution.—Coahuila to Sonora, Durango and San Luis Potosí.

Specimens examined.—COAHUILA: on the desert near Rancho Santa Teresa, south of Castanos, Municipio de Castanos, 19 June 1936, *Wynd and Mueller* 191 (Ariz, NY, US).

SONORA: arroyo del Pulpito near Colonia Oaxaca; alt. 3550 ft., 3 August 1938, *White* 759 (Ariz).

DURANGO: in open shrubbery, Yeranis, alt. 6200 ft., 24 August 1939, *Shreve* 9128 (Ariz).

SAN LUIS POTOSI: Charcas, July-August 1934, *Lundell* 5437 (Ariz); on flat of black volcanic soil 20 miles northeast of San Luis Potosí, 29 August 1947, *Webster, Barkley and Paxson* 827 (Texas).

S5 **Ruellia puberula** (Leonard) Tharp and Barkley, COMB. NOV.

Ruellia nudiflora var. *puberula* Leonard, Wash. Acad. Sci. 17: 517. 1927.

The following specimens were examined: GUATEMALA: Gualan, elev. 620 ft., 17 June 1909, *Deam* 6318 (US type) and Gualan, elev. 620 ft., 16 June 1909, 6318 (NM).

* See page 4.

S6 RUELLIA INTERMEDIA Leonard, Wash. Acad. Sci. 17: 573. 1927.

The following specimens were examined: CHIHUAHUA: Guasaremoso, Rio Mayo, 2 August 1935, *Gentry* 1546 (Ariz, Calif, Gray, IBM, NY, Phila, US); Rio Aros, 23 July 1937, *LeSueur* 1436 (Gray).

SONORA: 1 mile east of railroad on road from Carbo to Horcasitas, 17 September 1934, *Wiggins* 7275 (Ariz).

Fig. 6.—*Ruellia Metzae* Tharp. Type.

SINALOA: en campos de mais, September 1931, *Bravo* 299-7965 (IBM); Las Palmas, *Gonzalez* 0.745 and San Ignacio, 805 (IBM).

JALISCO: Bolano, 10-19 September 1897, *Rose* 2915 (US).

Wiggins 7275, *Gonzalez O.* 745 and *LeSueur* 1436 are somewhat atypical and when more material is available may prove to be varietally distinct.

1. **Ruellia Metzae*** Tharp, SP. NOV.

Herbacea perennis caulescens; caule 15-55 cm. alto, sparse hirsuto, obtuse quadrangulato; foliis spathulato-oblanceolatis vel anguste ovatis, obtusis vel subacutis, cuneatis ad basem, undulatis, 1-3 cm. latis, 3.5-14.5 cm. longis; inflorescentis terminalibus; corollis albis, 5.5-6.5 cm. longis, tubo cylindrico, 3 cm. longis plus minusve.

Perennial from a subligneous base; roots tough, thick-fibrous, clustered; stems branching from base, bunched, the branches spreading-ascending, 15-55 cm. long; secondary branches numerous, erect-ascending, more or less densely puberulent and sparsely to moderately hirsute; lower internodes terete or nearly so, upper quadrangular; cystoliths obscured by pubescence; leaf-blades 3-12 cm. long, 1-4 cm. broad, oblong-lanceolate to narrowly oblong-ovate, basally narrowed into and decurrent upon petioles 1.5-6 cm. long, acute to rounded at apex, grayish-green above, paler beneath, short appressed-pubescent above, less so beneath, the margins undulate-dentate to obscurely undulate; leafless but bracted cleistogamous-flowered branches arising from many of the lower nodes; terminal inflorescence a narrow or broad, ample panicle with sharply ascending to spreading branches, very viscid-glandular throughout; calyx at anthesis 16-20 mm. long, united for 1 mm., the lobes linear-subulate, green with a manifest mid-nerve, and frequently a purplish sub-cartilaginous tip, 1.2-1.5 mm. broad at base, outer surface densely viscid-pubescent throughout, inner surface glabrous except near apex; corolla white, 5.5-6.5 cm. long, very slightly curved, tube 3-3.6 cm. long, 2.5 mm. thick, throat 2 cm. long, 15 mm. broad at base of lobes, limb 3-4 cm. broad, lobes 12-14 mm. broad, 10-12 mm. long, broadly rounded to shallowly notched, undulate; anterior pair of filaments 11-14 mm. long, posterior 9-10 mm. all sparsely retrorse-hispidulous; anthers white, narrowly oblong, 4 mm. long, 1 mm. broad, the free sagittate basal portion of sacs .8 mm. long; style 4.5-5 cm. long, rather densely short spreading-pubescent toward base, sparsely so toward apex; stigma nearly 3 mm. long, .5 mm. broad, shorter lobe a flange-like ridge; ovary oblong, 4 mm. long, 1.5 mm. thick, green, densely puberulent, glandular on upper half, seated on a swollen white glabrous cartilaginous base 1 mm. high with a bright purple line at junction with ovary; fruit 16-22 mm. long, 4-5 mm. thick, broadest at or slightly above center, densely puberulent, glandular-viscid, particularly on upper half, the cartilaginous stipe-like base 1 mm. high, brown; retinacula angulate below, the mostly acute curved portion pale buff, 1.5 mm. long, the basal "stalk" brown, 1 mm. long; seeds brown, 9 or fewer in each cavity, orbicular, the hilum indented, the hygroscopic-viscid pubescence apparent only on the margins.

* See page 4.

Type.—Ridgetop School playground, Travis County, 7 July 1946, *B. C. Tharp* 46054 in the University of Texas Herbarium.

Distribution.—Limestone soils, central Texas to the border of New Mexico.

Specimens examined.—TEXAS: *Berlandier* 1586 (Gray); *Buckley s. n.* pp. (Phil); Metcalfe's, 29 July 1932, *Cory* 4696 (Gray); 1881, *Havard s. n.* (US); 1892, *Nealley* 86 (Texas) and 96a (US); south fork of Brady's Creek,* October 1850, *Thurber* 79 (Gray); Western Texas to El Paso, (May to) October 1849, *Wright* 431 (Calif, Gray, US); *Wright* (Phil); BEXAR CO.: San Antonio, 14 August 1906, *Ball* 905 (RM, US); hills north of San Antonio, 7 September 1900, *Eggert s. n.* (MBG); low ground near Kelly Field, 1 April 1932, *Metz s. n.* (NY) and waste, Woodlawn Avenue in San Antonio, 22 June 1932, 77 (CalA); in grassy field, San Antonio, 15 June 1932, *Moldenke* 6994 (NY); dry mesquite woods, Rio Cibolo, 20 September 1839, *Ridell s. n.* (US); 15 miles north of San Antonio, 23 October 1921, *Schulz* 740 (US); San Antonio, 1918, *Slater s. n.* (US); San Antonio River, 8 June 1929, *Whitehouse s. n.* (Texas); BLANCO CO.: Prairies, July 1885, *Reverchon s. n.* (US); 11 June 1939, *Tharp s. n.* (NY, Texas); BROWN CO.: rich valley lands, 11 August 1877, *Reverchon s. n.* (Gray) and rich prairie, Brownwood, 14 August 1877, 724 (MBG, US); BURNET CO.: Burnet, alt. 1300 ft., 17 July 1937, *Fisher* 37226 (Field); sandy soil on bank of Colorado River near Buchanan Dam, 28 July 1946, *Gentry* 20 (Texas); southeast corner of the county 19 June 1895, *Hill* 18 (US); Marble Falls, 28 June 1922, *Tharp s. n.* (Texas); COMAL CO.: growing in sandy soil, Bracken, 3 August 1903, *Groth* 134 (Field, Gray, US); GILLESPIE CO.: *Jermy s. n.* (MBG); GRAYSON CO.: Denison, 12 May 1932, *Coppin s. n.* (Texas); KENDALL CO.: Boerne, 28 July 1940, *Parks* Px2239 (Texas); KERR CO.: alluvial ground along River, Lacey's Ranch, 1 June 1916, *Palmer* 9983 (US); Kerrville, June 1929, *Westmoreland* (Texas); KIMBLE CO.: 10.5 miles northeast of Roosevelt, 19 May 1936, *Cory* 18976 (Gray); KINNEY CO.: Fort Clark, July 18—, *Blake* (NY); Anacacho Hills, 11 June 1938, *Cory* 29020 pp. (Gray); Spofford, 8-9 May 1904, *Griffiths* 6321 (MBG); Brackettville, 8 August 1925, *Tharp s. n.* (Texas); LLANO CO.: Granite outcrops near Llano, 4 August 1931, *Wolff* 3056 (US); MOTLEY CO.: along a fork of the Pease River near Matador, 30 April 1925, *Samll and Wherry* 12175 (NY); RUNNELS CO.: Ballinger, 1889, *Nealley* 392 (358) (US); SUTTON CO.: 21.3 miles southwest of Sonora, 1 July 1935, *Cory* 15193 (Gray); pasture L, substation 14, 28 July 1942, *Cory* 39626 (Gray); TOM GREEN CO.: Knickerbocker Ranch, Dove Creek, May 1880, *Tweedy* 2 (US); along South Concho River near Christoval, 6 July 1933, *Wolff* 4196 (Tracy); TRAVIS CO.: moist prairies, Daffan, September 1891, *Bodin* 214 (US); in meadows, Austin, 1 August 1936, *McCart* M184 (NTex); Austin, 15 June 1920, *Schulz* 743 (US); Austin, 15 July 1936, *Tharp* 44398 and 44399, two blocks east of Trinity Street, Austin, 5 August 1936, 44401, Cameron Road, Austin, 1 August 1938, *s. n.*, chalky soil at Austin, 22 July 1941, 46017, chalky soil north of Austin, 31 July 1945, 46013, Country Club golf links, Austin, 26 April 1946, 46033, Country Club golf links west of Red River Street, Austin, 27 April 1946, 46032, south of Mount Bonnell Road beyond Camp Mabry, 13 June 1946, 46048B, off Cameron Road about 3 miles from the University of Texas Campus, 7 July 1946, 46052, vacant property in Hyde Park, Austin, 7 July 1946, 46053, Ridgetop School playground at 7:15 P. M., 7 July 1946, 46054 and 9 July 1946, 46051 (Texas); mesquite and grassland opposite Camp Mabry rifle range, Austin, 8 July 1946, *Tharp, Oualline and Barkley* 16T466 (Texas); beyond Camp Mabry on Mount Bonnell Road across from rifle range, 27 April 1946, *York and Tharp* 46035 (Texas); along railroad near Austin, 13 June 1918, *Young s. n.* (Clokey, Texas); UVALDE CO.: 6 miles west of Montell, 4 July 1942, *Cory* 39441 (Gray, Texas); dry open places, Uvalde, 18 June 1917, *Palmer* 12301 (MBG, RM); eastern part of county, 10 October 1936, *Tharp* 44407 (Texas); Cline, 21 April 1925, *Wherry* s. n. (US); VAL VERDE CO.: 5.5 miles north of Del Rio, 1 July 1930, *Cory* 3491 (Gray); WILLIAMSON CO.: two miles north of Granger, 12 June 1939, *Tharp s. n.* (Texas); WILSON CO.: Sutherland Springs, August 1879, *Palmer* 2031 (Gray).

NEW MEXICO: 1851, *Wright* 1454 (Gray, NY).

* The only Brady Creek now identifiable is in McCulloch County.

1a. **Ruellia Metzae** var. **Marshii*** Tharp and Barkley, VAR. NOV.

Herbacea perennis caulescens; caule circa 10 cm. longo, dense albo-hirsuto; inflorescentis terminalibus, condensatis; foliis subcoriaceis, ovatis, subacutis, petiolis 2.5-6 cm. longis; corollis, caeruleo-purpureis vel albis, 7 cm. longis.

Stems low, 15 cm. tall or less, conspicuously hirsute and densely puberulent, becoming increasingly glandular but scarcely viscid in the inflorescence, two branches arising from each node, these usually foliage-bearing and like the main stem producing terminal panicles, the sub-basal ones occasionally leafless and producing each a trichotomous cyme of cleistogamous flowers; leafblades 2.5-4.5 cm. long, 1-2 cm. broad, obovate and rounded to lanceolate and acute, basally decurrent on the 1-2 cm. petioles, densely hirsute above, more sparsely so beneath, the margins more or less crenate-dentate and crisped; terminal panicles rather compact, 6 cm. long or less; calyx at anthesis 15 mm. long, the lobes green with manifest midnerve, 1.5 mm. broad, densely glandular-puberulent; corolla pale blue-purple or nearly white, 7 cm. long, tube 3.5-4.0 cm. long, throat 2 cm. long, the lobes orbicular, entire or sub-entire, rounded, 10-12 mm. in diameter, the limb about 3.5 cm. broad; stamens not dissected out; styles 2.5-4.5 cm. long; stigma linear-oblong, 2 mm. long, the short lobe manifest; fruits of expanding flowers lanceolate, 15-17 mm. long, slightly exceeding the calyx, 4.5 mm. broad, broadest near the middle, densely puberulent, somewhat glandular just below the apex; fruits of cleistogamous flowers similar to those of expanding flowers.

Type.—Muzquiz, Coahuila, spring 1935, *Ernest Marsh* 177 in the University of Texas Herbarium.

Distribution.—central west Texas to Coahuila and Chihuahua.

Specimens examined.—TEXAS: CONCHO CO.: Paint Rock, 20 April 1940, *Smith s. n.* (Texas).

COAHUILA: Muzquiz, spring 1935, *Marsh* 177 (Texas) and Agua Nuevo, Muzquiz, 9 July 1936, 314 (Texas).

CHIHUAHUA: five miles east of Cuidad Jimenez, elev. 4500 ft.±, 31 July 1939, *White* 2123 (Ariz, Gray, US).

While this variety is very similar to the var. *typica*, it is always long white-hirsute at least at first and the plants are much shorter than those of the species. In distribution it seems to be a southwestern dispersion from the species.

2. **Ruellia Muelleri*** Tharp and Barkley, SP. NOV.

Herbacea perennis caulescens; caule 15-60 cm. alto; foliis lanceolatic, acutis, cuneatis, repando-undulatis, 1.5-3 cm. latis, 6-12.5 cm. longis; inflorescentis terminalibus, anguste paniculatis; corollis albis, 5.5-8 cm. longis, tubo 3.5-4 cm. longo.

Perennial from a subligneous base; roots tough, thick-fibrous, clustered; stems branching from base, bunched, the branches spreading-ascending, 15-60 cm. long, subterete below and with both abundant fine cystoliths and coarse,

* See page 4.

crooked hairs; secondary branches numerous, ascending, more or less puberulent and sparsely to moderately hirsute; lower internodes often terete or nearly so, upper quadrangular; cystoliths fine, in irregular patches, or nearly absent; leaf-blades 3-10 cm. long, 1-4 cm. broad, lanceolate to narrowly ovate, basally narrowed, decurrent upon petioles up to 2 cm. long (the upper leaves sometimes sessile), obtuse or rarely acutish at apex, yellowish-green above, paler beneath, sparsely hirsutulous above and beneath, fine cystoliths present on both

Fig. 7.—*Ruellia Metzae* Tharp var. *Marshii* Tharp and Barkley. Type.

surfaces, margins manifestly undulate-dentate and somewhat crispid, ciliolate; leafless but bracted cleistogamous-flowered branches arising from some of the lower nodes; terminal inflorescence a narrow panicle with sharply ascending branches, glandular puberulent and somewhat viscid throughout; calyx at anthesis 12-20 mm. long, united for about 1.5 mm., the lobes linear-subulate, green with a manifest midnerve and usually subcartilaginous pale margins and tip, 1-1.2 mm. broad at base, outer surface densely coarsely puberulent with pale yellow glistening slightly viscid stalked glands throughout, inner surface more finely so and with some glistening glands; corolla white, 5.5-8 cm. long, slightly curved, tube 3.5-4 cm. long, 2-2.5 mm. thick, throat 2.5-3 cm. long, about 15 mm. broad at base of lobes, limb 3-3.5 cm. broad, lobes 10-15 mm. broad, about as long, broadly rounded and obscurely undulate; anterior pair of filaments 15 mm. long, posterior 12 mm., free portion sparsely retrorse-hispidulous; anthers white, narrowly oblong, 4.5 mm. long, 1.5 mm. broad, the free sagittate basal portion of sacs .9-1.1 mm. long; style 4.5-6 cm. long, sparsely short spreading-pubescent toward base, more sparsely so toward apex; stigma 2 mm. long, .5 mm. broad, shorter lobe a flange-like ridge or blunt deltoid cusp; ovary oblong, 4 mm. long, 1.5 mm. thick, densely puberulent, slightly glandular just below the apex; fruit 16-20 mm. long, 5-6 mm. thick, broadest at or slightly below the center, finely puberulent, obscurely glandular, not viscid; fruiting calyx 2.5 cm. long or less, barely exceeding the capsule; seeds brown, orbicular, the hilum scarcely indented, the hygroscopic-viscid pubescence manifest on the margins.

Type.—Open brush land near Puerto Sant Ana, Hacienda Mariposa, Muzquiz, Coahuila, 24 June 1936, *F. Lyle Wynd and C. H. Mueller* 266 in the University of Arizona Herbarium no. 30735.

Distribution.—Southern Texas and Coahuila.

Specimens examined.—TEXAS: BEXAR CO.:* near San Antonio, 1900-1902, *Wilkinson s. n.* (MBG).

Other specimens will be sought in the San Antonio area.

COAHUILA: open brush land near Puerto Sant Ana, Hacienda Mariposa, Municipio de Muzquiz, 24 June 1936, *Wynd and Mueller* 266 (Ariz, Gray, MBG, US).

2a **Ruellia Muelleri** var. **grandiflora** (Leonard) Tharp and Barkley, COMB. NOV.

Ruellia nudiflora grandiflora Leonard, Wash. Acad. Sci. 17: 516. 1927.

Perennial from a subligneous base; roots tough, thick-fibrous, clustered; stems branching from base, bunched, the branches erect-ascending, 30-40 cm. long; secondary branches numerous, ascending, more or less densely puberulent and sparsely to moderately hirsute; lower internodes sub-terete, upper quadrangular, cystoliths very fine, in part distributed in irregular patches and

* The fact that only one collection of so conspicuous a species has appeared from a long-popular region, and that we ourselves have not been able to re-locate it would seem to cast some doubt on the correctness of the locality from which the Wilkinson specimen came. It is entirely possible that the collection was actually made in Mexico by a resident of San Antonio and inadvertently included in a package of specimens from San Antonio.

more or less obscured by pubescence; leaf-blades 3-6 cm. long, 1-2 cm. broad, broadly to narrowly lanceolate, basally narrowed into and narrowly decurrent upon petioles 1.7 cm. long or less, mostly acute or rarely rounded at apex, yellowish-green above, paler beneath, finely puberulent above and beneath intermixed with scattered hirsutulous hairs, the margins obscurely undulate-dentate to subentire, ciliate; no evidence of leafless cleistogamous-flowered

Fig. 8.—*Ruellia Muelleri* Tharp and Barkley. Type.

branches, foliage branches two at a node; terminal inflorescence a narrow panicle up to 12 cm. long with short sharply ascending to spreading branches or these almost wanting, viscid-glandular; calyx at anthesis 15-17 mm. long, united for 2 mm., the lobes linear-subulate, yellowish-green with a manifest midnerve, 1-1.2 mm. broad at base, outer surface densely viscid-pubescent throughout, with dense eglandular appressed puberulence on inner surface; corolla apparently pale lavender, 6-6.5 cm. long, very definitely curved, tube 2.4-3 cm. long, 2 mm. thick at base, 3.5-4 mm. at junction with throat, throat 2 cm. long, 15 mm. broad at base of lobes, limb 3-4 cm. broad, lobes 15-18 mm. broad, 12-15 mm. long, broadly rounded to shallowly notched, undulate; free portion of anterior pair of filaments 12-13 mm. long, posterior 9 mm. long, an anterior and a posterior filament united for about 3 mm. above point of insertion on throat; anthers narrowly oblong, 4.5 mm. long, more than 1 mm. broad, the free sagittate basal portion of sacs 1 mm. long; style 4.5-5 cm. long, rather densely short spreading-pubescent toward base, sparsely so toward apex; stigma 2-2.5 mm. long, .5 mm. broad, shorter lobe manifest, lanceolate; ovary oblong, 4 mm. long, 1.5 mm. thick, densely puberulent, glandular on upper half; immature fruit densely puberulent, glandular-viscid, particularly on upper half.

Type.—near Yautepec, Morelos, Mexico, 12-13 July 1905, *J. N. Rose, J. H. Painter, and J. S. Rose* 8601 in the United States National Herbarium no. 452096.

Distribution.—This variety is known only from the type collection in the state of Morelos, Mexico.

Specimens examined.—MORELOS: near Yautepec, 12-13 July 1903, *Rose, Painter and Rose* 8601 (US).

3. **Ruellia occidentalis** (A. Gray) Tharp and Barkley, COMB. NOV.

Ruellia tuberosa occidentalis A. Gray, Syn. Fl. 2: 325. 1878, in part.

R. nudiflora occidentalis Leonard, Jour. Wash. Acad. Sci. 17: 516. 1927.

Perennial herb from clustered, tough, fibrous-fusiform roots; stems erect or ascending, subligneous at base, 3-7 dm. tall, internodes 12 cm. long or less, the lower subterete, middle and upper obtusely 4-angled, softly pale-glandular-pubescent, often bearing a leafy branch and a leafless (but bracted) early deciduous cyme from one or more of the lower nodes (sometimes 2 leafy or 2 floriferous branches at a node); leaf-blades ovate to very broadly ovate, 4-10 cm. long, 2-8 cm. broad, rounded at apex, rounded to subcordate (sometimes subtruncate) at base, usually abruptly decurrent on the upper part of the petiole, relatively thin to thickish, paler beneath than above, abundantly puberulent above and beneath, (thick-leaved specimens almost velvety) with long hairs on the margins and veins, veins more or less prominent, frequently conspicuously so; margins crenate-undulate to subentire; petioles 1-5 cm. long, densely pubescent and glandular like the stems; cleistogamous axillary cymes dichotomous, frequently bearing a bractless flower in one or more of the forks, often reduced to a single flower, but usually bearing 3 or more flowers; cleistogamous flowers (*Berlandier* 2489, Mo. Bot. Gard. 211784) with calyx lobes 9-11 mm. long at anthesis, linear-attenuate, pale glandular-pilose to the sharply

pointed curved tips; corolla 4-5 mm. long, slightly swollen just above base; anthers sub-sessile, oblong, sub-sagittate, 1-1.5 mm. long, .5 mm. broad; style 2 mm. long, stigma .6 mm. long, recurved; ovary 1.5 mm. long, oblong, bearing 5 ovules in each cavity; mature inflorescence of expanding flowers typically

Fig. 9.—*Ruellia Muelleri* var. *grandiflora* (Leonard) Tharp and Barkley. Type.

an ample inconspicuously bracted panicle of forking cymes with ascending to divaricate branches and with a sessile bractless flower frequently in some of the forks; pubescence of branches, pedicels, and calyces softly short-glandular-pilose and viscid, the calyx lobes 22-25 mm. long, linear-attenuate, pilose to the tips, united only at the very base; corolla (*Reverchon* 118, Mo. Bot. Gard. 211786) bluish-purple, 7 cm. long, 4 cm. broad, tube 27 mm. long, throat 25 mm. long, about 20 mm. broad at mouth, saccate below, inconspicuously glandular-pilosulous, lobes about 15 mm. long, almost as broad, broadly rounded, sub-erose; filaments adnate to upper end of corolla tube, an anterior and a posterior united for about 2 mm., the shorter (anterior) members 12 mm. long, the longer (posterior) 14 mm., anthers oblong, 4 mm. long, 1.4 mm. broad, sagittate at base, the lobes 1 mm. long; style about 4.5 cm. long, sparsely white-pilosulous, especially on the lower portion; stigma 2.5 mm. long, very slender, the shorter lobe obscure; ovary 3.5-4 mm. long, surmounting a 1-mm. cartilaginous ring, densely glandular-pilosulous; ovules 5-7 in each cavity; fruits from cleistogamous flowers 13-15 mm. long (about equalling the calyx lobes), 3.5 mm. broad, broadest above the middle, densely short-pilosulous, sparsely glandular on the upper portion; seeds 5 or fewer in each cavity; fruits from expanded flowers 16-20 mm. long (slightly to considerably shorter than the calyx lobes), 3-3.5 mm. thick, broadest near the middle, densely short-pilosulous seeds 5-7 in each cavity.

Type.—Berlandier, Texas. No specific specimen has been cited as the type but it is assumed that the specimen "Arroyo de la Leona de Medina a las Nueces, June 1834, Berlandier 2489=1059" in the Gray Herbarium is the type.

Distribution.—West and south Texas and in Mexico from Tamaulipas to Coahuila.

Specimens examined.—TEXAS: western Texas, 1890, *Neally s. n.* (Field); western Texas to El Paso, May-October 1849, *Wright* 430 (Calif, Gray, US), 1.5 to 2 feet high in shady place, Rio Grande east to the Medina, July-September 1849, s. n. (Gray), "New Mexico," 1851, 1451 (NY, Phila, US), and 1851-1852, 1455 (Calif, Gray, NY); ATASCOSA CO.: 45 miles south of San Antonio, 21 May 1921, *Schulz* 498C (US); BANDERA CO.S Arroyo de la Leona de Medina a las Nueces, June 1834, *Berlandier* 2489=1059 (Gray, MBG, Phila); BEXAR CO.: alt. 600 ft., San Antonio, 2 September 1933, *Vines* 3303 (Field); BROOKS CO.: west of Falfurrias, 25 June 1941, *Tharp* 46001 (Texas); CAMERON CO.: Old Cannon Resaca, 17 October 1943, *Davis* R31 (Davis, Texas); DIMMITT CO.: 2 June 1941, *Tharp* 46003 (Texas); JIM HOGG CO.: northeast of Hebbronville, 15 September 1942, *Lundell and Lundell* 11956 (SMU, US); KINNEY CO.: Anacacho Hills, 11 May 1939, *Cory* 29020 pp. and 29021 (Gray) and West Fork of Nueces River, 24 September 1939, 33476 (Gray); KLEBERG CO.: Kingsville, July 1940, *Sinclair* 46002 (Texas); LIVE OAK CO.: south part of county, 18 June 1928, *Tharp s. n.* and Grant Ranch in eastern part of county, 27 June 1941, 44406 (Texas); SAN PATRICIO CO,: limestone soil on xeric hills near Lake Corpus Christi, 13 June 1947, *Rowell and Webster* 2135 (Texas); UVALDE CO.: 9 miles southeast of Uvalde, 23 June 1935, *Cory* 15007 and Montell Creek, 10 September 1934, 9943 (Gray), 6 miles west of Montell, 4 July 1942, 39437 (Texas) and 39439 (Gray); Sabinal, 7 June 1916, *Palmer* 10111 (US); shaded rocks, rocky woods, Sabinal's Canyon, June 1885, *Reverchon* 1579 (Field, NY, US); VAL VERDE CO.: near mouth of the Pecos River, October 1883, *Havard* s. n. (Field); ZAVALLA CO.: 11.5 miles south of Uvalde on the Nueces River, 24 October 1934, *Cory* 11957 (Gray).

MEXICO: northern Mexico, *Berlandier* 2489 (Paris); Rinconada, 24 May 1847, *Gregg s. n.* pp. (MBG), west of Cerralbo, 24 May 1847, (MBG), 28 May 1847 (NY), and Walnut Grove, 27 May 1847 (MBG).

TAMAULIPAS: La Tamaulipeca near San Miguel, alt. 1900 ft., 26 July 1930, *Bartlett* 10637 (Field, US); alt. 1450 ft., 12 July 1933, *Fisher* 33027 (Gray, US); gravelly clap soil in oak rain forest west of Ciudad Monte, 29 August 1947, *Paxson, Webster and Barkley* 17M999 (Texas); river near San Vicente, Jaumave, July 1931, *von Rozynski* 379 and Sierra near Nogales, Jaumave, July 1932, 418 (Field); 9 kilometers

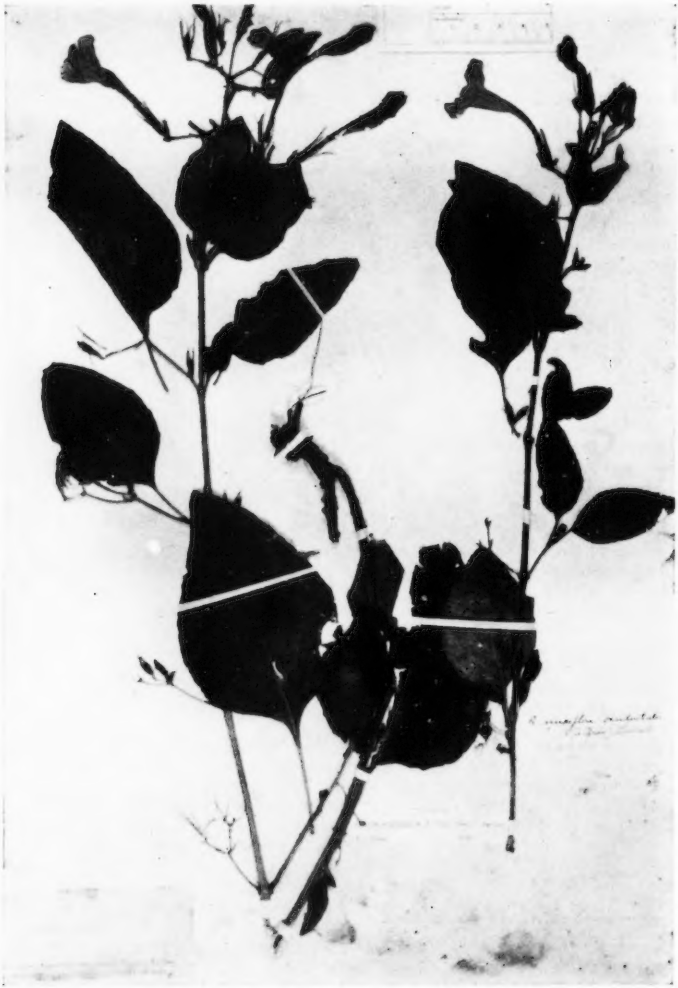


Fig. 10.—*Ruellia occidentalis* (A. Gray) Tharp and Barkley. *Charles Wright* 430; U. S. Nat. Herbarium no. 63858.

east of Palmillas on small creek surrounded by dry limestone hills, alt. 1750 meters, 15 August 1941, *Stanford, Retherford and Northcraft* 945 (Ariz, Gray, MBG) and 945 pp. (NY): chaparral near Mier on the lower Rio Grande, 31 May 1847, *Wislizenus* 372 (MBG).

NUEVO LEON: alt. 540 meters, Guadalupe, Monterrey, May 1911, *Abbon* 25 *and Arsene* 6143 (US); along an irrigation ditch, Monterrey, April 1891, *Dodge s. n.* (US); Monterrey, 1846, *Edwards and Eaton s. n.* (NY); Rancho Resendez, Lampazos, 24 June 1937, *Edwards* 329 (MBG); near Monterrey, 22 June 1848, *Gregg* 144 (MBG); Sabinas Hidalgo, 16 September 1937, *Kenoyer s. n.* (MBG); semi-desert mountains, Sabinas Hidalgo, elev. 2000 ft., 14 June 1940, *Leavenworth* 42 (Ariz, Field, Gray, MBG, NY); alt., 55-650 meters, limestone slope, Topochico northwest of Monterrey, 20 June 1934, Pennell 16889 (Phila, US); xerophytic region forty miles south of Laredo, 6 July 1941, *Schery* 10 (MBG); alt. 3650 ft., shaded slopes in Galeana Canyon six miles below Iturbide, 30 August 1940, *Shreve and Tinkham* 9773 (Gray); lower slopes of Cerro de la Silla near Monterrey, 22 June 1939, *White* 1459 (Gray).

COAHUILA: Piedras Negras to Monclova, 22-24 August 1938, *Johnston* 7021 pp. (Gray); Sabinas, 16 September 1937, *Kenoyer* 64 (Field); Morpresa Spring, Muzquiz, 8 July 1936, *Marsh* 347 (Texas); alt. 1400 ft., in shade along a wash 11 miles south of Allende, 23 August 1938, *Shreve* 8409 (Ariz, US); Hacienda Mariposa at the foot of the eastern slope of the Sierra de Puerto Santa Ana, Municipio de Muzquiz, 23 June 1936, *Wynd and Mueller* 241 (Ariz, Arnold, IBM, NY, MBG, US).

3a. **Ruellia occidentalis** var. **Lundelliorum** Tharp and Barkley, VAR. NOV.

Herbacea perennis caulescens; caule 7-8 dm. alto, piloso vel hirsuto ad basem, glanduloso-pubescenti ad apicem; foliis ovatis, obtusis vel acutis, 6-9.5 cm. latis, 14.5-19 cm. longis, membranaceis, undulatis; cymo-paniculis amplis, terminalibus, circa 35 cm. longis; corollis circa 5.5 cm. longis.

Stems herbaceous, tall (apparently up to 7-8 dm., only the upper portion embodied in available specimens), moderately hirsute below, increasingly glandular-pubescent upward in the panicle; leaves with blades narrowly to very broadly ovate, apically obtuse to acute, basally rounded and abruptly decurrent almost to the bases of the 2 to 3 cm. petioles, thin, conspicuously reticulate-veined, pale and softly puberulent beneath, deep green and sparsely appressed-hispid above, the margins undulate, 19 cm. long or less, 9 cm. broad or less; inflorescence an ample terminal cymose-panicle (with two lesser axillary panicles from the uppermost pair of leaves) up to 35 cm. long, 15 cm. broad, the ultimate cymules usually consisting of a sub-sessile bractless flower between two peduncles, each bearing a terminal pair of bractlets and a single short-pedicelled flower; calyx at anthesis 13-17 mm. long, the lobes linear, sharply purple-tipped, green with a dorsally manifest midnerve, densely spreading glandular-puberulent without, appressed eglandular puberulent within; expanding and cleistogamous corollas intermixed; the expanded corollas blue-purple, arcuate, the tube about 22 mm. long, throat about as long, basally rather saccate, 12-15 mm. broad at lobe bases, lobes broadly ovate, rounded, slightly emarginate, 10-12 mm. long, 8-10 mm. broad; stamens with longer filaments about 11 mm. long; ovary 3.5-4 mm. long, densely white-puberulent and sparsely glandular; style 4-4.5 cm. long, sparsely puberulent, stigma linear-ligulate, 2.5 mm. long, the short lobe an obscure concave flange; capsule 1.5 cm. long,

about as long as the calyx, 4-5 mm. thick, thickest at or above the middle, retrorse-puberulent except spreading at the apex; cleistogamous flower calyces 10-11 mm. long at anthesis, the lobes glandular-pilosulous without, obscurely appressed eglandular-puberulent within, green with a manifest whitish midrib

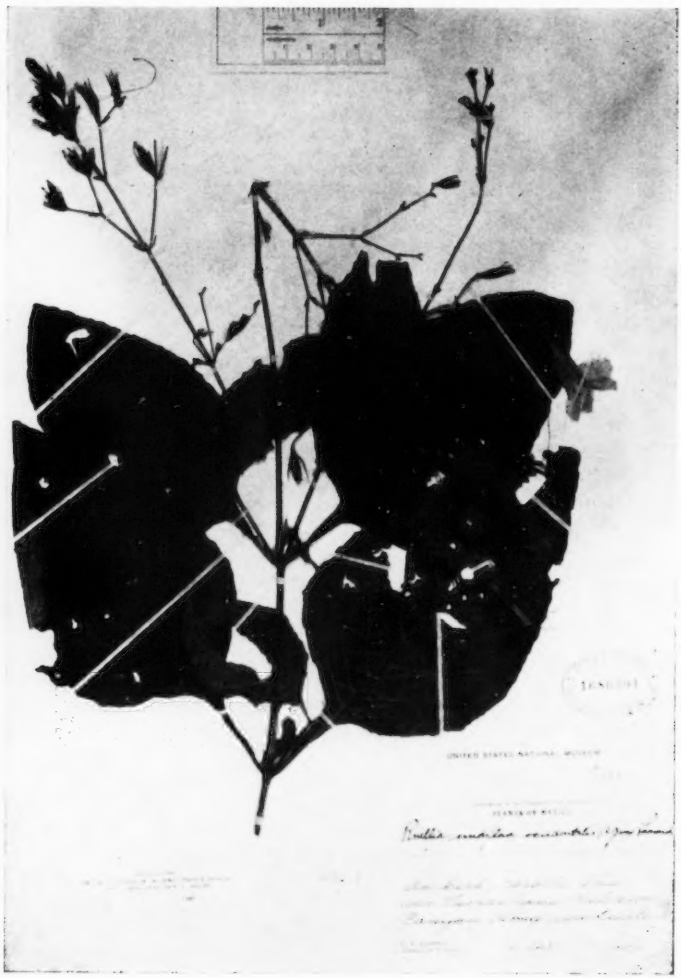


Fig. 11.—*Ruellia occidentalis* (A. Gray) Tharp and Barkley var. *Lundellorum* Tharp and Barkley. Type.

and a sharply pointed purplish tip; corolla 5 mm. long, 1.3 mm. broad, the tube constricted at center, lobes scarcely 1 mm. long, about as broad, obtusely angular at apex; filaments .5-.8 mm. long; anthers 1 mm. long, 2/3 as broad, oblong, basally short-lobed; style 2.5 mm. long, apically outcurved; larger stigma-lobe concave-deltoid, .2 mm. wide and long, shorter lobe very obscure, truncate; ovary 2.5 mm. long, 1 mm. thick with a cartilaginous circular base .3 mm. high, obscurely finely puberulent; ovules 5 in each cavity.

Type.—An herb with blue corolla, along roadside, Galeana Canyon, Tamaulipas, Mexico, July 1937, *Lundell and Lundell* 7281, in the U. S. National Herbarium, no. 1686201.

Distribution.—Known only from the type collection.

Specimens examined.—TAMAULIPAS :along roadside, Galeana Canyon, July 1937, *Lundell and Lundell* 7281 (SMU, US, (sheet numbered 1686201 only)).

3b. **Ruellia occidentalis** var. **Wrightii** Tharp and Barkley, VAR. NOV.

Herbacea perennis caulescens, puberulento ad basem, glanduloso ad apicem; foliis ovatis, obtusis, 2-5 cm. latis, 8-13 cm. longis, paniculis angustis, rigidis; corollis circa 5 cm. longis.

Stems retrorsely and very finely eglandular-puberulent below, becoming densely glandular in the inflorescences; leaves thin and only moderately puberulent with less prominent veins, broadly acuminate at base on short petioles (up to 2 cm.); panicle narrow with relatively stout, rigid, erect-ascending branches, the pubescence hirsutulous-glandular; calyx lobes less narrowed apically; subulatish, hirsutulous-glandular; corolla tube 35 mm. long, the lobes 10-12 mm. long, about as broad; capsules 4-5 mm. thick, rather densely hirsutulous and slightly glandular.

Type.—*Wright* 431 in part as to the specimen to the left in the Torrey Herbarium.

The only specimen observed is attached to *Wright's* 431 "collected in Expedition from Western Texas to El Paso, New Mexico, May-October 1849." No locality is given. A fragmentary specimen of *R. yucatana* on the same sheet casts some doubt on the authenticity of the label, for *R. yucatana* is not known to occur along the route followed by the expedition of 1849.

This variety differs in several respects from the species. The leaves are thinner and only moderately puberulent, with less prominent veins, on shorter petioles. The panicles are narrow with relatively stout rigid branches, its pubescence hirsutulous-glandular. The corolla tube is longer and thicker, and the lobes smaller. The capsules are thicker and are rather densely hirsutulous.

3c. **Ruellia occidentalis** var. **Ferrisae** Tharp and Barkley, VAR. NOV.

Herbacea perennis caulescens; caule circa 3 dm. alto, dense pubescentii; foliis ovatis vel late ovatis, 4-10 cm. longis, 2-8 cm. latis, obtusis, dense pubescentibus; paniculis amplis terminalibus; corollis purpureis, 4-4.5 cm. longis.

Roots clustered, tough fibrous-fusiform; stems erect or ascending, subligneous at base, 3 dm. tall; internodes 5 cm. long or less, the lower subterete, middle and upper obtusely 4-angled, densely and softly pale-eglandular-pubes-

cent to the inflorescence, often bearing 2 leafy branches at a node; leaves with petioles 5-15 mm. long, densely pubescent and eglandular like the stems, the blades ovate to very broadly ovate, 4-10 cm. long, 2-8 cm. broad, rounded at apex, abruptly acuminate at base and decurrent on the upper part of the petiole, thickish, paler beneath than above, abundantly puberulent above and beneath, with longer hairs on the veins, margins crenate-undulate to subentire;

Fig. 12.—*Ruellia occidentalis* (A. Gray) Tharp and Barkley var. *Wrightii* Tharp and Barkley. Type (Left). *Ruellia yucatana* (Leonard) Tharp and Barkley. (Right).

mature inflorescence of chasmogamous flowers typically an ample inconspicuously bracted panicle of forking cymes with ascending to divaricate branches and with a sessile bractless flower frequently in some of the forks; pubescence of the branches, pedicels and calyces softly short-glandular-pilose, scarcely viscid; calyx lobes 17-20 mm. long, linear-attenuate, pilose to the tips, united only at the very base; corolla bluish-purple, 4-4.5 cm. long, 2.5-3 cm. broad, tube 10-12 mm. long, throat 20 mm. long, about 14 mm. broad at mouth, saccate below, inconspicuously glandular-pilosulous, the lobes about 10-12 mm. long, almost as broad, broadly rounded to shallowly notched, sub-erose; fruits not seen.

Type.—Known only from the type collection: NUEVO LEON: Sierra Madre Mountains, Monterrey, 6 July 1933, *C. H. Mueller and M. T. Mueller* 114, in the Gray Herbarium of Harvard University. This specimen bears the same number and essentially the same data as the very different specimen in the Herbarium of the Chicago Natural History Museum which is the type of *R. nudiflora* var. *Berlandieri*.

4. **Ruellia strictopaniculata** Tharp and Barkley, SP. NOV.

Herbacea perennis caulescens, 3-7 dm. alta sed lignea ad basem, dense puberulenta; foliis ovatis vel ovato-lanceolatis, 4-10 cm. longis, 2-4 dm. latis, acuminatis vel subtruncatis, membranaceis; inflorescentiis paniculatis strictis terminalis, cum floriis cleistogamis et chasmogamis; clycis segmentis filiformis; corollis chasmogamis 4.5-6 cm. longis; capsulis dense pilosulis et glandularis ad apicem.

Stems erect or ascending, usually ligneous at the base, 3-7 dm. tall, internodes 12 cm. long or less, the lower subterete, middle and upper obtusely 4-angled, densely puberulent, eglandular (becoming sparsely glandular pilosulous in the inflorescence); leaf with blade ovate to ovate-lanceolate, 4-10 cm. long, 2-4 cm. broad, acute or acuminate to sub-rounded at apex, acuminate-decurrent at base, relatively thin, paler beneath than above, abundantly puberulent above and beneath with longer hairs on the margins and veins, veins more or less prominent, margin crenate-undulate to subentire; petioles 1-4 cm. long, puberulent like the stems; cleistogamous flowers abundant in the terminal panicles, the calyx lobes 4-8 mm. long at anthesis, flexuous, linear-attenuate, pale glandular-pilose to the sharply pointed tips; corolla 3-4.5 mm. long, slightly swollen just above the base, "throat" constricted, lobular apex swollen; anthers subsessile, oblong, sub-sagittate, .8-2 mm. long, .5 mm. broad; style 1.5+ mm. long, stigma .6 mm. long, recurved, ovary 1.5-2 mm. long, oblong, ovules 3-4 in each cavity; mature inflorescence of expanding flowers typically a strict narrow, ample, inconspicuously bracted panicle of appressed, short-peduncled or subsessile congested cymes, up to 10 cm. long; pubescence of branches and pedicels scarcely glandular, that of calyces softly short-glandular-pilose but scarcely viscid; calyx lobes 13-15 mm. long, linear-attenuate, glandular-pilose to the tips, united about 1.5 mm. at base; corolla bluish-purple, 4.5-6 cm. long, 2.5-3 cm. broad, tube 20-23 mm. long, throat 16-20 mm. long, about 8-10 mm. broad at mouth, tapering and scarcely saccate below, inconspicuously glandular pilosulous, lobes about 7-9 mm. long, 6-7 mm, broad, broadly rounded, sub-

erose; filaments adnate to upper end of the corolla tube, an anterior and a posterior united for about .5 mm., the shorter (anterior) members 9 mm. long, the longer (posterior) 9.5 mm.; anthers oblong, 3 mm. long, 1 mm. broad, sagittate at base, the lobes scarcely 1 mm. long; style about 3.5 cm.

Fig. 13.—*Ruellia occidentalis* (A. Gray) Tharp and Barkley var. *Ferrisae* Tharp and Barkley. Type.

long, sparsely white-pilosulous, especially on lower portion; stigma 2 mm. long, very slender, the shorter lobe obscure; ovary 2.5-3 mm. long, surmounting a .5 mm. cartilaginous ring, densely puberulent, glandular on the upper half; ovules 5-6 in each cavity; fruits of cleistogamous flowers 10-11 mm. long (exceeding the calyx lobes), 2.5-3 mm. broad, broadest above the middle, densely short-pilosulous, sparsely glandular on the upper portion; seeds 4 or fewer in each cavity; fruits of expanded flowers 13-15 mm. long (as long as the calyx tubes or longer), 2.5-3 mm. thick, broadest near the middle, densely short-pilosulous; seeds 5-6 in each cavity.

Type.—Near spring, la Palma Resaca, Cameron County, Texas, 23 September 1945, *L. I. Davis* R34 in the University of Texas Herbarium.

Distribution.—Known only from Cameron County, Texas.

Specimens examined.—TEXAS: CAMERON CO.: la Palma Resaca, 25 July 1943, *Davis* R33 (Davis, Texas), October 1943, R36 (Davis), 23 September 1945, R32 and R 34 (Davis, Texas).

5. **Ruellia Davisiorum** Tharp and Barkley, SP. NOV.

Herbacea perennis; caule erecto, herbaceo excepto ad basem subligneo; foliis ovatis, hirsutis et glanduloso-pubescentibus, 2-3 cm. latis, 4.5-7 cm. longis, subacutis vel subtruncatis ad apicem, ad basem subtruncatis; paniculis terminalibus glanduloso-pilosis, strictis; corollis chasmogamis 5.5-6 cm. longis; capsulis pubescentibus.

Roots clustered, tough, coarsely fibrous; stems erect and herbaceous except the sub-ligneous base or becoming ligneous and greatly elongated during mild winters and under the protection of other vegetation; internodes 6 cm. long or less, the lower subterete, the middle and upper obtusely 4-angled, densely and softly pale flavo-pubescent and somewhat glandular, a foliar branch and a leafless flowering branch frequently opposite each other at the lower and middle nodes; leaves with petioles 1-3 cm. long, densely pubescent and glandular, the leaf-blades ovate, 3-6 cm. long, 1.5-3.5 cm. broad, subacute to rounded at apex, rounded at base, abruptly short-decurrent, relatively thickish, paler beneath than above, both surfaces subvelvety-puberulent and somewhat glandular, veins more or less prominent, margins obscurely crenate-undulate to subentire, occasionally somewhat crisped; axillary cymes from lower and middle nodes more or less persistent, dichotomous, frequently bearing a bractless cleistogamous flower in one or more of the forks, sometimes reduced to a single flower, usually bearing 3 or more flowers; terminal panicles usually an admixture of a few chasmogamous and many cleistogamous flowers, its branches, pedicels and calyces abundantly glandular-pilosulous; cleistogamous flowers with calyx lobes 9-11 mm. long (12-15 mm. in fruit), linear-attenuate, pale glandular-pilosulous to the sharply pointed tips; corolla 3.5-4.5 mm. long, more or less swollen just above the base; filaments .4 mm. long, anthers oblong, subsagittate, .6-.7 mm. long, .4 mm. broad; style 1.5-2 mm. long, stigma .6 mm. long, recurved; ovary 2 mm. long, ovules 4-5 in each cavity; chasmogamous flowers with calyx-lobes 20-22 mm. long, linear-attenuate, pilose to the tips; corolla 5-6 cm. long, 3.5 cm. broad, the tube 22 mm. long, throat 20 mm. long,

about 1.5 mm. broad at the lobe bases, saccate below, inconspicuously glandular-puberulent, lobes 12-14 mm. long, almost as broad, sub-erose; (stamens not dissected for examination); style about 3.5 cm. long, sparsely pilosulous below, stigma 1-1.5 mm. long, very slender, the shorter lobe obscure, ovary 3-4

Fig. 14.—*Ruellia strictopaniculata* Tharp and Barkley. Type.

mm. long, densely glandular-pilosulous, ovules 5-7 in each cavity; cleistogamous fruits 11-13 mm. long, somewhat shorter than the calyx-lobes, 2.5 mm. broad, broadest about or above the middle, the pubescence retrorse below, spreading and somewhat glandular toward the apex; chasmogamous fruits 10-12 mm. long (slightly to considerably shorter than the calyx-lobes), 3 mm. thick, broadest near the middle, densely short-pilosulous becoming glandular below the apex; seeds 5-7 in each cavity.

Fig. 15.—*Ruellia Davisiorum* Tharp and Barkley. Type.

Fig. 16.—*Ruellia Davisiorum* Tharp and Barkley. *Robert Runyon* 4204-2, deposited in the Herbarium of the University of Texas.

Type.—On gravel hills, Hidalgo County, Texas, November 1927, *Robert Runyon* 160 in the U. S. National Herbarium 1438261.

Distribution.—Southern Texas to adjacent Mexico.

Specimens examined.—TEXAS: 1901-1908, *Bray s. n.* (Texas); CAMERON CO.: north of Brownsville, 28 October 1927, *Rose and Russell* 24272 (NY, US); alluvial soil by Arroya Colorado near Rio Hondo, 28 July 1937, *Runyon* 3254 (Runyon), in open ground, Brownsville, 8 October 1938, 2002 (Field), near Rio Hondo, 13 July 1941, 4046 (Runyon), and Rio Hondo, 24 June 1946, 4204 (Texas); HIDALGO CO.: November 1927, *Runyon* 160 pp. (US), on dry ground, 20 June 1928, *s. n.* pp (US) and two miles west of La Joya, 13 July 1941, 4142 (Texas); La Joya, 21 October 1945, Davis R37 (Davis, Texas); LIVE OAK: 7 miles south of George West, 26 December 1946, *Albers* 46369 (Texas); southern part of county, 1 August 1936, *Tharp* 44396 (Texas); VAL VERDE CO.: along Devil's River, 11 September 1900, *Eggert s. n.* (MBG).

MEXICO—TAMAULIPAS: Buena Vista Hacienda, 16 June 1919, *Wooten s. n.* (US).

NUEVO LEON: in loam soil, semishade along brooklet leading from Ojo de Aqua Nogolar about 5 miles north of Monterrey, 18 August 1944, *Hernandez, Maldenado and Barkley* 14583A (Texas); xeric scrubland five miles west of Santa Catarina along dry creekbed, 12 July 1946, *Hernandez, Rowell and Barkley* 16M546 (Texas); limestone hillside near Monterrey below the Obispado, 25 February 1946, *Johnson and Barkley* 16036M (Texas).

6. RUELLIA PANICULATA L., Sp. Pl. 635. 1753.

Perennial from tough conspicuously branched roots which arise at the bases of erect stems or from the lower nodes of an occasional basally decumbent portion; stems 3-6 dm. long, herbaceous or occasionally sub-ligneous, densely greyish puberulent and somewhat glandular throughout, becoming more coarsely so upward, essentially terete throughout, vegetative (non-floriferous) branches rare; leaves with petioles about 1 cm. long or considerably shorter upward, leafblades broadly ovate to ovate-lanceolate, usually acute, rarely obtuse and apiculate, 2 to 7 cm. long, 1 to 3 cm. broad, densely coarse-puberulent and somewhat glandular on both surfaces, dull green, somewhat paler beneath than above, the margins entire to obscurely undulate; inflorescence of ample divaricately-dichotomous, multi-branched, cymose, bracteate panicles which both terminate the stem and arise normally in pairs at each of the numerous nodes; flowers sessile singly in the forks and at the bracteolate tips of the ultimate branchlets; calyx at anthesis 9-13 mm. long, the lobes linear, each with a manifest green midvein, glandular-hirsutulous and slightly viscid without, glabrous within except the very apex which is sparsely glandular; corolla about 2.5 cm. long or rarely longer, 2-2.5 cm. broad, the lobes about 6 (-8) mm. long and broad, apically rounded, the margins undulate; throat 10-12 mm. long, about 10 mm. broad at lobe bases, obconic, rather densely fine-puberulent, tube 10-13 mm. long, 1.5 mm. thick, prominently 10-striate-nerved; filaments adnate to the base of the throat, the anterior 7 mm., the posterior 5 mm. long, an anterior and a posterior fused for about 1.5 mm. at the base, anthers oblong, 3 mm. long, 1.5 mm. broad, apiculate, the basal lobes about .6 mm. long, rounded; style about 15 mm. long, stigma 1 mm. long, ligulate, the short lobe obsolete; ovary 3 mm. long, .8 mm. thick, glabrous, surmount-

ing a corneous basal disk .4 mm. high; ovules 5-6 in each cavity; cleistogamous flowers apparently wanting; capsules glabrous, linear to linear-oblanceolate, 12-14 mm. long, 2-2.5 mm. thick, gradually narrowed to the base, sharply acute at the apex; seeds 5-6 in each cavity (or sometimes fewer), broadly elliptic, flat, 1.5 mm. long.

Fig. 17.—*Ruellia paniculata* L. *Edward Palmer* 108; U. S. Nat. Herbarium 463043.

Type.—A Linnaean species, the type not seen.

Distribution.—Texas to Chiapas.

Specimens examined.—TEXAS: NUECES CO.: Corpus Christi, September 1860, *Virden s. n.* (MBG).

MEXICO.—TAMAULIPAS: Altamira in sylvis, February 1831, *Berlandier* 771 and 2191 (Gray, MBG, NY, Phila); alt. 15 meters, 1-31 January 1910, *Palmer* 108 (CalA, Field, Gray, US); alt. 1250 meters, April 1913, *Viereck* 1084 (US); Nogales, Juamave, 1932, *von Rozynski* 275 (Field).

VERA CRUZ: Panuco river near Ebano, 28 February 1939, *LeSueur* 447 (Ariz, Texas); *Altamirano* 1839 (IBM); Las Garzas, January 1939, *Matuda* 2675 (Ariz, SMU); 8 February 1896, *Seler and Seler* 7839 (IBM).

7. **Ruellia Drushelii*** Tharp and Barkley, SP. NOV.

Herbacea perennis, albo-hirsuto; caule circa 10 cm. alto; foliis ovato-lanceolatis, 1-1.5 cm. latis, 2.5-5 cm. longis, obtusis vel acutis; inflorescentii terminalibus; corollis 3.5-4.5 cm. longis; capsulis 1.5 cm. longis, pubescentibus.

Roots perennial, clustered, fibrous; stems low, usually less than 15 cm. tall, branched, pubescent (usually densely so) with coarse crooked jointed hairs toward the base, these usually mixed with a dense puberulence which becomes increasingly apparent and glandular toward and in the inflorescence; leaves with petioles usually 15 mm. long or less, blades ovate to narrowly so, 2-4 cm.

* See page 5.

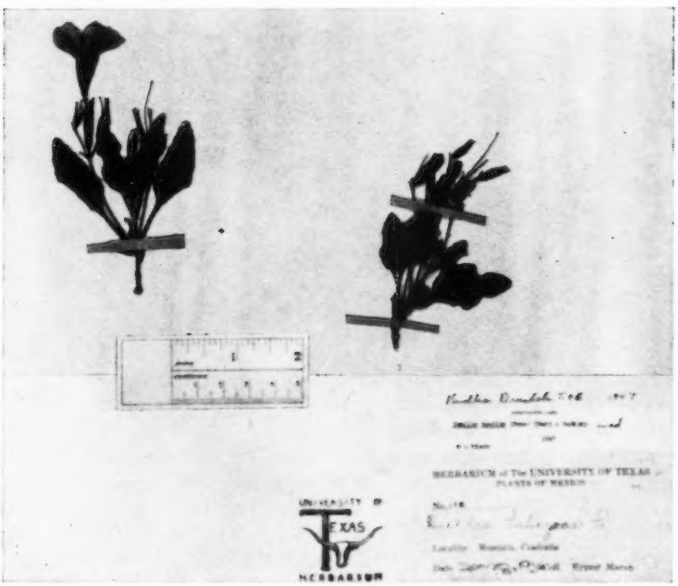


Fig. 18.—*Ruellia Drusheli* Tharp and Barkley. Type.

long, 1-2 cm. broad, obtuse to acute at apex, rounded and abruptly acuminate-decurrent to subcuneate at base, more or less densely pubescent above and below with coarse hairs similar to those on the stem, the margins crisped and more or less crenate-undulate; inflorescences terminal on main stem and branches, cymose, flowers frequently 3 but occasionally reduced to 1 or elaborated into a small panicle; cleistogamous flowers apparently few (immature fruits with short styles attest their occurrence?); chasmogamous flowers showy, pale blue-lavender; calyx-lobes 15-17 mm. long (at anthesis), .7 mm. broad at base, linear-filiform, softly white-hirsutulous, the erect hairs tipped with viscid brown glands; corolla 3.5-4.5 cm. long, the tube about 12 mm. long, throat 2 cm. long, 1.5 cm. broad at base of lobes, lobes 10-12 mm. broad, 9-10 mm. long, emarginate; filaments adnate to the mouth of tube, the longer 12 mm., the shorter 9 mm. long, anthers 2.5 mm. long, oblong, .6 mm. broad; style 2 cm. long, sparsely puberulent toward base; stigma ligulate, 2 mm. long, the short lobe obscure; ovary 3.5 mm. long; cleistogamous fruits 12-15 mm. long, about equalling the calyx-lobes, 3.5-4 mm. thick, densely retrorsely-puberulent toward base, increasingly glandular toward apex, frequently tipped by the 1.5 mm. recurved style and the .5 mm. ligulate stigma; fruits of expanded flowers somewhat longer, 16-18 mm., retrorsely hispid except at the apex, scarcely glandular, scarcely as long as the calyx; seeds orbicular, about 2 mm. diameter, light brown, the white hygroscopic pubescence usually manifest without wetting.

Type.—Muzquiz, Coahuila, Mexico, Spring 1935, *Ernest Marsh* 178 in the University of Texas Herbarium.

Distribution.—Southwestern Texas to Tamaulipas and Coahuila.

Specimens examined.—TEXAS: April 1895, *Bolton s. n.* (KanSt); Rio Grande in west Texas, *Jermy s. n.* (NY); KINNEY CO.: Fort Clark, 10 May 1893, *Mearns* 1440 (US).

MEXICO: Walnut Grove, 27 May 1847, *Gregg s. n.* pp., west of Cerralbo and Rinconada, 24 May 1847, *s. n.* pp. (MBG).

TAMAULIPAS: San Fernando to Jimenez, 26-27 February 1902, *Nelson* 6605 (Gray).

NUEVO LEON: Monterrey, 24 June 1848, *Gregg* 187 (MBG); Burro Mountain, *Jermy* 146 (US); Monterrey, 26 May 1847, *Wislizenus* 327 (MBG).

COAHUILA: Muzquiz, spring 1935, *Marsh* 178 (Texas).

7a. **Ruellia Drushelii** var. **macrocarpa** Tharp and Barkley, VAR. NOV.

Herbacea perennis, albo-hirsuta; caule 35 cm. alto; foliis ovatis, 2-5 cm. longis, 1-3 cm. latis; paniculatis terminalibus, 3-25 cm. longis; corollis 4-5 cm. longis; capsulis circa 2 cm. longis.

Roots perennial, clustered, fibrous; stems up to 35 cm. tall, branched, pubescent with coarse crooked jointed hairs toward the base, these usually mixed with a dense puberulence which becomes increasingly apparent and glandular toward the inflorescence; leaves with petioles up to 3 cm. long, blades narrowly to broadly ovate, 2-5 cm. long, 1-3 cm. broad, obtuse to subacute at apex, rounded and more or less abruptly acuminate-decurrent at base, manifestly more or less densely hirsute above and below with coarse hairs similar

to those on the stem, the margins crisped and more or less crenate-undulate; inflorescence terminal, cymose-paniculate, the branches dichotomous with a subsessile flower in each fork; cleistogamous flowers apparently few; chasmogamous flowers showy, pale blue-lavender; calyx lobes 17-19 mm. long at anthesis, .9 mm. broad at base, linear-filiform, softly white hirsutulous, the erect hairs tipped with viscid brown to almost black glands; corolla 4-5 cm. long,

Fig. 19.—*Ruellia Drusheli* var. *macrocarpa*. Tharp and Barkley. Type.

the tube 10-12 mm. long, throat 1.5-2 cm. long, 1.2-1.5 cm. broad at base of lobes, lobes 10-14 mm. broad, 10-12 mm. long, rounded to obscurely emarginate; style 18-22 mm. long, sparsely puberulent toward base; stigma ligulate, 2 mm. long, the short lobe obscure; ovary 3.5 mm. long; cleistogamous fruits up to 18 mm. long, equalling or exceeding the calyx-lobes, up to 5 mm. thick, densely retrorsely-puberulent toward base, glandular toward apex, frequently tipped by the ligulate stigma; immature fruits of the expanded flowers longer, somewhat glandular, shorter than the calyx (up to 24 mm.).

Type.—Forty miles south of Monterrey, Nuevo Leon, 24 June 1935, *Drushel* 9410 in the Missouri Botanical Garden Herbarium no. 1111869.

Distribution.—Southern Texas to Nuevo Leon, Mexico.

Specimens examined.— TEXAS: 1890, *Nealley* 301 (US).

NUEVO LEON: forty miles south of Monterrey along Federal Highway, 24 June 1935, *Drushel* 9410, (MBG, US).

8. RUELLIA NUDIFLORA (A. Gray) Urban, Symb. Antill. 7: 382. 1912; Leonard, Jour. Wash. Acad. Sci. 17: 512. 1927.

Dipteracanthus nudiflorus Engelm. and Gray, Bost. Jour. Nat. Hist. 5: 229. 1845.
Ruellia tuberosa auths., non L., Sp. Pl. 634. 1753.

Perennial from a suffruticose base; stems in the spring 2.5 dm. tall or less, later becoming 6-7 dm. tall or less, erect or decidedly ascending, not decumbent at base, bright green except the purplish lower 1 to 2 cm. of each internode, in the spring densely puberulent and sparsely hirsute, later essentially glabrous to the lower branches of the inflorescence, thence densely glandular-pubescent; basal and lower leaf-blades in spring aspect oblong to narrowly oblong-ovate, 6 cm. long or less, 3 cm. broad or less, gray-green above and beneath, strongly reticulate beneath, moderately densely short pubescent on both surfaces, distinctly crisped, undulate-dentate, with a narrow ciliate cartilaginous margin and sub-glandular callosities on marginal vein-tips, decurrent on petioles up to 2.5 cm. long; leaves in the summer aspect 12 cm. long or much reduced above, the ovate blade 3 to 4 times as long as the petiole, basally attenuate, apically rounded or acute, (the uppermost pair reduced, almost sessile), sparingly pubescent above, essentially glabrous beneath except the slightly pubescent nerves, the margins entire or undulate, sometimes somewhat crisped, green; floriferous axillary branches produced in the spring, 3-11 cm. long, bearing usually 3 flowers or rarely 1-flowered through non-development of laterals, the central flower pedicelled without bractlets, each of the 2 lateral flowers on a short peduncle which bears 2 bractlets below the pedicel; flowers cleistogamous; calyx lobes 10 to 11 mm. long, linear-attenuate, densely glandular puberulent and with a few longer hairs, the mid-vein and margins greenish; corolla 4 mm. long, lobes 1.5 mm. long, the base of the tube cylindric, throat not constricted; stamens inserted separately; filaments almost wanting, anthers 1 mm. long; stigma ligulate, essentially sessile, .2 mm. thick; fruiting calyx-lobes 14 to 16 mm. long, green, densely puberulent especially beneath and with glandular-ciliate margins; inflorescence in the summer aspect chasmogamous, terminal,

paniculate; bracts of the inflorescence progressively reduced and increasingly glandular upward, linear-oblong, the lower ones 1.5 cm. long; lowermost peduncles of the terminal panicle 2.5 cm. long or less, glandular-pubescent; sepals subulate-attenuate, 11-15 mm. long in flower, slightly longer in fruit,

Fig. 20.—*Ruellia nudiflora* (Engelm. and Gray) Urban. Type.

densely glandular-puberulent but not at all viscid; corolla purplish-blue, conspicuously curved, about 5.5 cm. long, about 3.5 to 4 cm. broad, opening about sunrise, falling during early afternoon, tube 15-20 mm. long, 2 mm. thick, 10 ridged-striate, throat 18-23 mm. long, oblong, rather abruptly narrowed to tube, 12-15 mm. across at base of lobes, lobes 7-9 mm. broad, 12-14 mm. long, oblong, rounded, slightly erose, yellow anteriorly inside at base; longer filaments 12 mm., the shorter 11 mm. long; anthers purplish, slightly sagittate, 4 mm. long, introrse; style 4 cm. long; longer stigma lobe 2.5 mm. long, .5 mm. broad, purple; shorter stigma lobe essentially wanting; ovary 3.5 mm. long, green, densely eglandular-puberulent, surmounting a cartilaginous basal ring; ovules 8 to 9 in each cavity; capsules from cleistogamous flowers about 15 mm. long, 3.5-4 mm. thick, clavate, densely retrorse-puberulent; seeds 4-5 in each cavity, brown, about 3.5 mm. long, 3 mm. broad; capsules from chasmogamous flowers 16-20 mm. long, about equalling the calyx, 4-4.5 mm. thick, thickest above the middle (or rarely below), densely fine-puberulent; seeds 18 or usually fewer, dark brown, about 3 mm. long, scarcely as broad, rounded or apiculate at apex.

Type.—Texas, 1843, *F. Lindheimer,* Fasc. I. 157. The specimen ex Herb. Gary in the University of California Herbarium (no. 248433) is the only one which fits the description in detail.

Distribution.—Texas, Nuevo Leon and Tamaulipas.

Specimens examined.—TEXAS: *Berlandier* 2489 (Phila); *Drummond s. n.* (Gray), 257 (Gray, NY), and 221 (Gray, NY); *Lincecum and Buckley s. n.* pp. (Phila); *Lindheimer* 157 (Phila), bottoms of streams, July 1943, Fasc. I, 157 (Calif, Field, Gray, Paris), 1846, Fasc. III 157 (Calif, MBG, NY), 1846, Fasc. III 505 (US) and 1847 Fasc. IV 508 (Gray); *Parry Bigelow, Wright and Schott* 721 (NY); *Wright s. n.* (Gray, NY); AUSTIN CO.: Brazos River on the Houston to San Antonio Highway at 2:30 P. M., 11 July 1946, *Tharp* 46055 (Texas); Industry, 1890, *Wurzlow s. n.* (Field) and Industry, 1894, 33 (US); BASTROP CO.: pine hills, 15 July 1928, *Duval s. n.* (Texas); BELL CO.: prairie between camps, Camp Hood, 2 September 1943, *Cohn and Barkley* T65 (Texas); shady, moist, rocky soil on Salado Creek in Salado, 8 August 1938, *McDaniel s. n.* and in roadside near Temple, 4 June 1939, 4 (NTex); blackland weeds, 31 July 1931, *Wolff* 3015 and near Sparta, 27 September 1933, 4808 (Tracy); BEXAR CO.: dry meadows near San Antonio, 14 August 1906, *Ball* 904 (NY, US); common in woods, San Antonio, 20 September 1907, *Bush* 857 (MBG); vacant lot at Army Post, 10 August 1931, *Clare* 77 (Calif, Cath, Paris); tropical life zone, San Antonio, 27 April 1911, *Clemens* 1049 (MBG); San Antonio valley, 8 September 1900, *Eggert s. n.* (MBG); San Antonio, 11 July 1921, *Fisher* 1031 (US); San Antonio, 1881, *Havard s. n.* (US); *Jermy s. n.* (Calif) and 59 (US); waste lots in San Antonio, 27 April 1940, *von Schrenk s. n.* (MBG); BLANCO CO.: infrequent along a stream about eight miles east of Johnson City, 26 June 1946, *Warnock* 46484 (Texas); BOSQUE CO.: about 4 miles south of Clifton along Highway, 1 September 1946, *Pudig and York* 46348 (Texas); BRAZORIA CO.: Columbia, 24 April 1900, *Bush* 147 (Gray, MBG, NY, US), and common on prairie, Columbia, 1 November 1899, 313 (MBG, US); BRAZOS CO.: dry uplands, 29 August 1899, *Ness s. n.* (Tracy); 3 October 1946, *Paxson* 500 (Texas); dry open woods, College Station, 29 May 1915, *Palmer* 7811 (Calif, NY, US); about 4 miles north of Bryan, 23 April 1940, *Reeves* 162 (US), roadside park north of Bryan, 23 April 1940, 162A, 162B, (Tracy), woods, College Hills Estates, College Station, 22 July 1940, 166 (US), near lot 13, College Hills, 22 July 1940, 166A, 166B (Tracy), fertile soil near barn lot near landscape nursery, College Station, 29 July 1940, 169 (US), in foreman's yard in Hensel's Nursery, 29 July 1940, 169A, 169B (Tracy), and spring 1941, 1431 (Tracy); BROOKS CO.: west of Falfurrias, 25

June 1941, *Tharp* 4600 (Texas); BROWN CO.: rich valley lands, 11 August 1877, *Reverchon* 835 (NY); BURLESON CO.: Lyons, May 1927, *Martin s. n.* (Texas); ten miles east of Caldwell in open oak woodland near stream, 20 July 1946, *Stern, Johnson, Barkley* and Rowell 27 (Texas); CALHOUN CO.: Port Lavaca, October 1849, *Trecul* 1065 (Paris); Port Lavaca, *Wright s. n.* (KanSt); CALDWELL CO.: Maxwell, 7 August 1938, *Strandtmann s. n.* (Texas); CAMERON CO.: Olmito, 12 July 1942, *Davis* R30 (Davis, Texas), northeast of Laguna Vista, 19 May 1946, R6, R 15 (Davis), Barreda, 23 June 1946, R9 (Davis, Texas); heavy sandy loam at Brownsville, 1942, *Shiller* 878 (US); COLORADO CO.: low open ground, Eagle Lake, 18 September 1914, *Palmer* (US); 30 June 1939, *Tharp s. n.* (Texas); COMAL CO.: growing in sandy soil, Bracken, 3 August 1903, *Groth* 134 (NY) and vicinity of Bracken, 1903, 258 (Gray); New Braunfels, July 1850, *Lindheimer* 319 (KanSt, MBG), and Commanche Spring, New Braunfels, July 1851, 1066 (Ariz, Calif, Field, Gray, MBG, NY, Okla, Paris, Phila, Texas, US); DALLAS CO.: common in low ground, Dallas, 10 May 1900, *Bush* 707 (MBG); Dallas, *Dapprich* 7416 (SMU); Dallas, *LeRoy* (NY); near Bachman's Dam in sandy elm-oak woods, 30 May 1940, *Lundell and Lundell* 9168 (Gray, SMU, US); low, rich lands, Dallas, August, *J. Reverchon s. n.* [*Curtiss* 1945] (Field, Gray, MBG, NY, Phila, US), rich bottom land near Dallas, 1875, 723 (MBG), Bos-fords, riche tene, Reunion, July 1876, *s. n.* (Field), Dallas, August 1876, 411 (Gray), rich prairies, Dallas, June 1877, *s. n.* (NY), rich low lands, Dallas, July 1879, *s. n.* (Field) and Dallas, 12 July 1900, *s. n.* (MBG); along roadside, rare, 2 October 1929, *Ruth* 1579 (SMU); vicinity of Dallas, rare, 10 May 1929, *Stephenson* 93 (US); DE WITT CO.: black soil, 3 July 1941, *Riedel s. n.* and in sand, 5 August 1941, 46009 (Texas); FAYETTE CO.: .75 mile south of Monument Hill, 27 July 1934, *Cory* 10087 (Gray); GALVESTON CO.: Galveston, 28 September 1912, *Fisher and Williams s. n.* (Phila); La Porte, 9 August 1913, *Fisher* 628 (US) and alt. 40 ft., Genoa, 22 June 1938, *Fisher* 38225 (Field); GILLESPIE CO.: black soil on limestone outcrops, Edwards Plateau ten miles west of Fredericksburg, 22 September 1944, *Barkley* 14525 (Texas); GONZALES CO.: Palmetto State Park, 29 June 1946, *Albers* 16T485 (Texas); *Hildebrand s. n.* (US); Gonzales, 1929, *Tharp s. n.* (Texas); GUADALUPE CO.: Seguin, 22 July 1900, *Earle* 431 (US); Seguin, 22 July 1900, *Earle and Earle* 431 (NY); HARRIS CO.: Houston, July 1927, *Armer s. n.* (Texas); 3 miles east of Addicks, 9 July 1943, *Boon* 211, 2800 Bellaire, Houston, 12 July 1946, 261, U. S. Navy Hospital, Houston, 13 July 1946, 260, South Sims Bayou 1 mile from its mouth, 13 July 1946, 262, 1800 McGregor Drive, Houston, 13 July 1946, 263, McGregor Park, Houston, 13 July 1946, 264, San Jacinto Battleground, 13 July 1946, 265, South Sims Bayou .5 miles from its mouth, 13 July 1946, 266, and 1 mile west of bridge on Highway 225, 13 July 1946, 267 (Texas); Hockley, *Coulter* 7965 (Field); Houston, 6 July 1912, *Fisher* 92 (US), 7 July 1912, *s. n.* (CalA, Clokey); wet soils, Houston, 8 April 1872, *Hall* 427 pp. (Gray) and 427 (Field, NY, US); bottom of Sim's Bayou near Galveston, July 1842, *Lindheimer* 143 (MBG); dry open ground, Houston, 17 September 1915, *Palmer* 8569 (CalA, NY, US); Houston, 20 September 1877, *Ward s. n.* (US); HAYS CO.: infrequent beneath oaks in Limestone soil four miles south of Dripping Springs, 27 July 1946, *Krodel and Warnock* 46525 (Texas); in shade in woodland along the San Marcos River, 2 August 1946, *Paxson and Barkley* 16T505 (Texas); bank of San Marcos Lake, 21 July 1940, *Tharp* 44386 (Texas); sandy soil on Onion Creek near Dripping Springs, 27 July 1946, *Warnock and Krodel* 12-b (Texas); JEFFERSON CO.: Beaumont, 9 August 1937, *Tharp s. n.* (Texas); JIM WELLS CO.: sandy soil fifteen miles north of Falfurrias, 24 May 1945, *Wolcott and Barkley* 16T333 and 16T335; JACKSON CO.: Edna, 5 August 1933, *Degener* 5162 (NY); Lavaca River, 28 August 1941, *Tharp s. n.* (Clokey, Gray); KENDALL CO.: Spanish Pass, 11 August 1942, *Parks* Px2016 (Tracy); KERR CO.: 1941, *Shiller s. n.* (Tracy); KLEBERG CO.: King Ranch, Kingsville, 20 June 1937, *Reed and Cory* 33777 (Tracy); Riviera, 3 July 1925, *Tharp s. n.* (Texas); KIMBLE CO.: Junction, *School* 5993 (Texas); KINNEY CO.: Spofford, 18 June 1893, *Wooten* 126 (US); LA SALLE CO.: on bank of Rio Frio near Fowlerton, 30 July 1921, *Ferris and Duncan* 3040 (CalA); LAVACA CO.: Lavaca River bottom, 30 July 1947, *Tharp* 47454 (Texas); MATAGORDA CO.: 14.3 miles north of Palacios, 18 September 1936, *Cory* 20275 (Gray); frequent along highway 1 mile southeast of Bay City in Beaumont Clay, 14 June 1946,

Warnock 46305 (Texas); McLENNAN Co.: Waco, 21 July 1929, *Whitehouse s. n.* (Texas); shore of Lake Waco, 27 June 1947, *Rowell, Barkley and Webster* 7109 (Texas); MONTGOMERY Co.: 1 August 1935, *Parks* 14525 (Gray); NAVARRO Co.: on calcareous prairie near Frost, 18 June 1939, *Bryant* 16 (Texas); sandy roadside near City Lake, Corsicana, 31 July 1938, *McClure* 8 (NTex); black calcareous loam, 1 to 2 miles north of Corsicana along the T. and B. V. RR., 11 September 1913, *Pennell* 5417 (NY); rich woods, Corsicana, 25 April 1902, *Reverchon* 3213 (MBG, US); NUECES Co.: Corpus Christi, 10 April 1930, *Benke* 5434 (Field, US); ten miles northwest of Corpus Christi, 16 June 1937, *Cory* 33776 (Tracy); near Corpus Christi, March 1894, *Heller s. n.* (NY) and elev. 40 ft., Corpus Christi, 6-12 March 1894, *Heller* 1417 (Calif, NY, Phila, US); Corpus Christi, May 1913, *Orcutt* 5859 (MBG); black soil of wooded bottom of Petronilla Creek, 26 May 1946, *Wolcott and Barkley* 16T395 (Texas); ROBERTSON Co.: woods about 8 miles north of Bryan, 7 July 1940, *Reeves* 165 (US); SAN PATRICIO Co.: Ingleside, 19 September 1936, Cory 20403 (Gray) and northwest of Gregory, 25 July 1944, 45392 (Texas); SUTTON Co.: underpass on Sutton County road, 7 July 1940, Reeves 165a, 1656 (Tracy); TARRANT Co.: in rich woods, valley of the Trinity, 6 August 1914, *Ruth* 546 (NY, Phila, RM, US); TRAVIS Co.: dry upland prairie, 8 July 1943, *Barkley* 13096 (Clokey, Texas), limy loam hilltop in Austin, 8 June 1946, 16Y461 and limy loam upland, Austin, 22 October 1946, 16T499 (Texas); Cretaceous Limestone, west branch of Onion Creek five miles south of Austin, 9 August 1946, *Barkley and Copeland* 70 (Texas); mowed lawn of campus at The University of Texas, 29 July 1946, *Gentry* 16 (Texas); Austin, July 1935, *Hurst s. n.* (Texas) and 10114 (Field, Texas, US); in railroad relict on blackland soil near Manor, 11 October 1940, *Rose-Innes* 115 (Gray); Govalle near Austin, 10 September 1931, *Ross* 5993 (Texas, US); Anderson's Mill to Jollyville, 4 July 1935, *Smith s. n.* (Texas); frequent in open woods in the vicinity of Austin, 22 October 1942, *Taylor* 3057 (Calif, Texas); Lake Austin, 6 August 1936, *Tharp s. n.*, Austin, 20 July 1940, 46016B, Austin, 26 July 1941, 46005, limestone soil, Austin, 2 September 1941, 45007, Hyde Park in Austin, 19 September 1945, 46014, Del Rio Clay along Shoal Creek Boulevard below 24th Street, Austin, 25 April 1946, 46030 and 46031, and 27 April 1946, 46034, Del Rio Clay along east side of Shoal Creek Boulevard two blocks south of 24th Street, Austin, 20 June 1946, 46049, off Cameron road about three miles from University of Texas campus, 7:00 P. M., 7 July 1946, 46048A, under trees in Del Rio Clay on Shoal Creek Boulevard below 24th Street, 7 July 1946, 46050 and from 25th and University Avenue in Austin, 15 July 1946, *s. n.*; Willow Brook Addition, Austin, 24 October 1946, 47452 (Texas); sparsely wooded grassland near 32nd and West Avenue in Austin, 8 July 1946, *Tharp, Oualline and Barkley* 16T464, off Camp Mabry Road near Austin, 8 July 1946, 16T463 and Del Rio Clay in fill in open sunlight on Shoal Creek Boulevard below 24th Street, 7 July 1946, 16T465 (Texas); black limy soil at Shoal Creek in Austin, 1 August 1945, *Tharp and Warnock* 46015; Shoal Creek in Austin, 29 September 1908, *York and Wolf* 44 (Texas); Austin, June 1929, *Whitehouse s. n.* (Texas); VAN ZANDT Co.: roadside ditch near Canton, 3 July 1939, *Williams* 8 (NTex); VICTORIA Co.: Victoria, September 1930, *Shiller s. n.* (Texas, US) and Da Costa, 10 September 1927, 5976 (Texas); WALLER Co.: prairies near Hempstead, 12 June 1872, *Hall* 426 (Field, MBG, NY, US); WASHINGTON Co.: 20 June 1938, *Brackett s. n.* (Texas); near Brenham, 15 July 1929, *Whitehouse s. n.* (Texas); WHARTON Co.: Wharton, 10 September 1930, *King s. n.* (Texas); 2 September 1937, *Tharp s. n.* (Texas); in woods near Pierce, 14 September 1901, *Tracy* 7641 (NY) and Pierce, 16 September 1901, 7642 (Field, Gray, NY, Texas, US); Wharton, 15 July 1933, *Whitehouse s. n.* (Texas); WILLIAMSON Co.: two miles north of Granger, 12 June 1939, *Tharp s. n.* (Texas); near Brushy Creek at Fern Bluff Crossing about three miles west of Round Rock, 9 June 1946, *York* 4612E (Texas); WILSON Co.: Sutherland Springs, August 1879, *Palmer* 1007 (Gray) and Sutherland Springs, September 1879 to October 1880, 2031 (Phila).

NUEVO LEON: C. I. Obispado, Monterrey, 12 October 1895, *Seler and Seler* 1103 (NY).

TAMAULIPAS: near Llera near Ciudad Victoria, 26 August 1937, *White* 27 (Field).

8a. **Ruellia nudiflora** var. **Mirandae*** Tharp and Barkley, VAR. NOV.

Herbacea perennis caulescens; caule 30-75 cm. alto, pili minutis, obtuse quadrangulato vel subtereto; foliis late ovato-lanceolatis, subcoriaceis, undulato-serratis; subacutis, 4-7.5 cm. longis, 1.4-3.5 cm. latis; paniculis terminalibus, amplis; calycis segmentis 11-12 mm. longis, subulatis, dense glanduloso-pubescentibus; corollos albis, 4.5-5 cm. longis.

Plant perennial, herbaceous or often subligneous at the base, 30-75 cm. tall, nodes 4.5-9 cm. long, often with a single leafy branch from one or more of the lowermost nodes, branches erect-ascending; cleistogamous flowering branches wanting; basal internodes subterete, densely hirsutulous to glabrate but with fine cystoliths, upper internodes obtusely quadrangular and grooved between the angles, hirsute and puberulent to subglabrate, eglandular to the inflorescence; leaves ovate to broadly ovate-lanceolate, petioles of lowermost leaves .8-2 cm. long, not much shortened upward, blades moderately to distinctly thick, margin more or less crisped, undulate-serrate, apex acute to obtuse, base cuneate or rounded and decurrent, 4-7.5 cm. long, 1.4-3.5 cm. broad, scarcely reduced above, densely hirsutulous-pilosulous beneath, less so above; inflorescence an ample terminal panicle, branches erect-ascending; flowers chasmogamous, calyx at anthesis with lobes 11-12 mm. long, 1.2 mm. broad at base, subulate, densely hirsutulous-glandular-pubescent, slightly viscid; corolla white, 4.5-5 cm. long, tube 2.5 cm. long, gradually expanding into a narrow throat, limb about 2.5-3 cm. broad, lobes about 1 cm. long and broad, broadly rounded, tube and throat finely puberulent and slightly glandular especially on the veins; fruits not seen.

Type.—Known only from the type collection: SAN LUIS POTOSI: 1000 ft., lowlands, Tamasopo, 8 July 1896, *C. G. Pringle* 7287 in the Gray Herbarium at Harvard University.

9. **Ruellia Corzoi*** Tharp and Barkley, SP. NOV.

Herbacea perennis caulescens, ad basem subligniis, 1.5-3.5 dm. altis, albo-hirsutis et ad apicem glanduloso-puberulentis; foliis spatulatis vel lanceolatis, truncatis vel subacutis, 4-6 cm. longis, 15-25 mm. latis; corollos 3 cm. longis; capsulis puberulentis et ad apicem glandularibus.

Roots mixed fibrous and fusiform-thickened; stems erect or nearly so from a subligneous base, 1.5-3.5 dm. tall, branched throughout, the branches more or less sharply ascending, conspicuously hirsute from base to inflorescence with spreading hairs which become increasingly interspersed with glandular puberulence in the inflorescence, quadrangular with increasingly manifest grooves on the faces from base to tip; leaves with blades oblanceolate to narrowly ovate, rounded to subacute at apex, 4-6 cm. long, 15-25 mm. broad, the lower surface moderately hirsute, upper more densely so, the margins obscurely crenate to subentire, scarcely crisped, acuminate-decurrent on petioles 1-2 cm. long; inflorescences of two kinds: (1) trichotomous simple or compound

* See page 5.

Fig. 21.—*Ruellia nudiflora* (Engelm. and Gray) Urban var. *Mirandae* Tharp and Barkley. Type.

Fig. 22.—*Ruellia Corzoi* Tharp and Barkley. Type.

leafless but bracted cymes of pedicelled cleistogamous flowers usually from one member of each pair of lower branches (the other member elongated, leafy and following the branching pattern of the main stem), and (2) narrow terminal panicles 5-10 cm. long, of chasmogamous, essentially sessile flowers, the larger branches being each subtended by a leaflike bract; chasmogamous flowers with calyx-lobes 11-14 mm. long, scarcely 1 mm. broad at base, green throughout, obscurely nerved and densely glandular-pubescent without, nerveless and eglandular-puberulent within; corolla bluish-purple, about 3 cm. long, tube 8-9 mm. long, throat 11-13 mm. long, rather abruptly contracted into the tube, lobes suborbicular, scarcely 1 cm. in diameter; cleistogamous fruits lanceolate-clavate, densely retrorse-puberulent and glandless below middle to spreading or ascending puberulent and increasingly glandular toward apex, 16-18 mm. long, 3.5 mm. thick, thickest above middle; chasmogamous fruits not seen.

Type.—On the desert near Rancho Santa Teresa, south of Castaños, Municipio de Castaños, Coahuila, 19 June 1936, *F. Lyle Wynd and C. H. Mueller* 191 in the Herbarium of the Missouri Botanical Garden no. 1112963.

Distribution.—Southern Texas and northern Mexico.

Specimens examined.—TEXAS: BEXAR CO.: San Antonio, 17 August 1923, *Richter s. n.* (Texas); CAMERON CO.: fish hatchery, 23 June 1946, *Davis* R8 (Davis, Texas).

NUEVO LEON: open gravelly grassland near Santa Catarina, 28 February 1946, *Alonis Johnson and Barkley* 16186M (Texas); in areas protected by shrubs, 12 July 1946, *Hernandez, Rowell and Barkley* 16M547A (Texas), in areas not protected by shrubs in xeric scrubland five miles west of Santa Catarina, 12 July 1946, 16M549 (Texas); near Rio Ramos 20 kilometers northwest of Montemorelos, 1 August 1942, *Weaver* 1027 (Gray).

COAHUILA: on the desert near Rancho Santa Teresa south of Castaños, 19 June 1936, *Wynd and Mueller* 191 (Gray, MBG).

10. **Ruellia Runyonii*** Tharp and Barkley, SP. NOV.

Herbacea perennis caulescens; caule sparse et obscure hirsuto, 30-75 cm. alto; foliis lanceolatis vel anguste oblongo-ovatis vel spathulatis, subcoriaceis, undulato-serratis vel subintegris et crispis, subacutis, 4-7 cm. longis, 1.4-3 cm. latis; paniculis terminalibus amplis; corollis 3.5-4 cm. longis; capsulis 13-20 cm. longis, glanduloso-puberulis.

Plant perennial by short rhizomes, herbaceous or often subligneous at the base, 30-75 cm. tall, nodes 4.5-9 cm. long, often with a single leafy branch (or very rarely two) from one or more of the lower nodes, the branches ascending, the cleistogamous flowering branches each opposite a leafy branch or without a leafy branch opposite, basal internodes subterete, glabrate, with fine cystoliths, upper internodes obtusely quadrangular and grooved between the angles, glabrate to puberulent, at first very sparsely hirsute with coarse crooked hairs and occasionally sparsely glandular; leaves lanceolate to narrowly oblong-ovate or spatulate, petioles of lowermost leaves .8-3 cm. long, much shortened upward, blades moderately thick, margin more or less crisped, finely undulate-serrate, apex acute to obtuse, base cuneate and decurrent, 4-7 cm. long, 1.4 to 3 cm. broad, reduced above, glabrate or more or less pubescent, especially on the veins; inflorescence (1) an ample terminal panicle (and sometimes pani-

* See page 5.

cles in the axils of the uppermost leaves), the branches ascending (except uppermost branchlets sometimes divaricate), and (2) pedunculate lateral cymes of one to usually three (or rarely more) cleistogamous flowers in the axils of most of the lower leaves; cleistogamous flowers with calyx sparsely

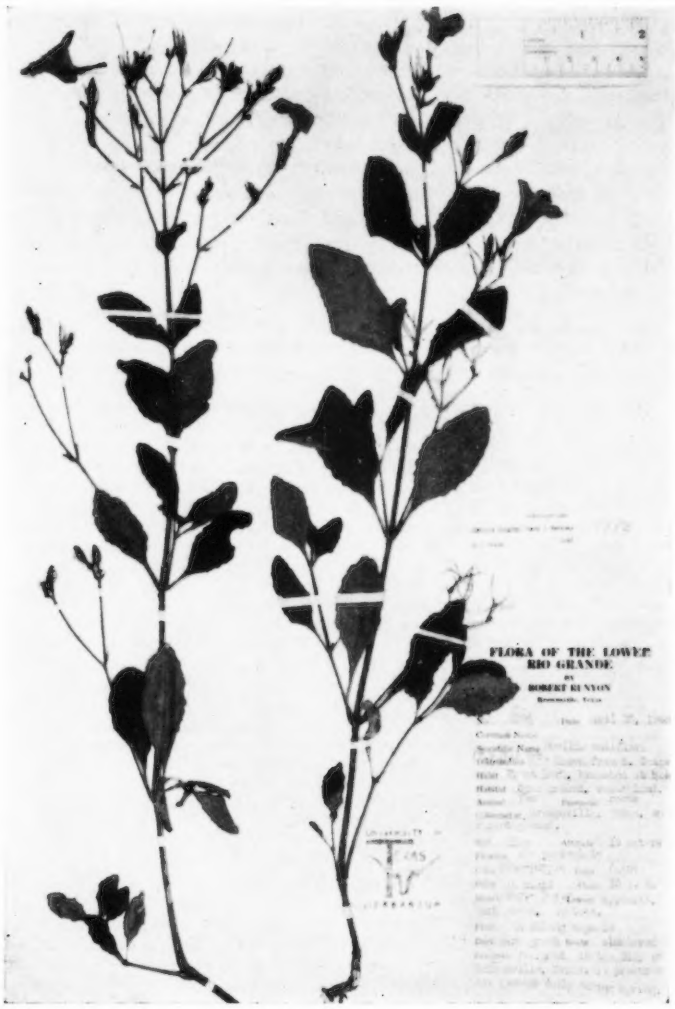


Fig. 23.—*Ruellia Runyoni* Tharp and Barkley. Type.

glandular-pubescent, lobes filiform, .5-.7 mm. broad at base, 9-13 mm. long, somewhat viscid; corolla 4 mm. long, 1.5 mm. thick, lobes 1 mm. long and broad, broadly rounded; stamens with filaments united in pairs at the base, the united portion decurrent on corolla tube, the free portion of filaments .5 mm. long, anthers sagittate, 1.2 mm. long, the style 2 mm. long, stigma 1 mm. long, broadly ligulate, uncinate, the shorter lobe obsolete; ovary 1.5 mm. long; chasmogamous flowers deep bluish-purple, the calyx at anthesis united for 1-2 mm. at the base, lobes 9 to 14 mm. long, 1 mm. broad at base, attenuate to filiform tips, rather densely short-stalked glandular-pubescent, slightly viscid; corolla 3.5-4 cm. long, tube .8-1 cm. long, abruptly expanded into the throat; throat 1.1-1.5 cm. long, limb about 2-3 cm. broad, lobes about .8-1 cm. long and broad, broadly rounded; style 18-20 mm. long; stigma 1.5 mm. long; fruits from cleistogamous flowers 13-15 mm. long, about 4 mm. broad, oblanceolate in outline, puberulent, glandular toward apex; fruits of chasmogamous flowers 15-20 mm. long, about 2.5-4.5 mm. broad, broadest in center, tapering at both ends, densely glandularly puberulent and slightly viscid, particularly on upper portion.

Type.—On vacant ground in Brownsville, Cameron County, Texas, 25 April 1946, *Robert Runyon* 4186 in the University of Texas Herbarium.

Distribution.—Southern Texas and from Tamaulipas to Coahuila.

Specimens examined.—TEXAS: BEXAR CO.: common in woods, San Antonio, 20 September 1901, *Bush* 856 (MBG); in ravine at south end of San Antonio Experiment Farm, 15 April 1907, *Headley s. n.* (US); 1904, *Jermy* 38 (NY), San Antonio, 266 (Gray, US), and 60 (MBG); waste places, San Antonio, 1 June 1932, *Metz* 77 (CalA, Okla); near San Antonio, 1900-1902, *Wilkinson s. n.* (MBG); CAMERON CO.: Southmost, July 1941, Davis R53, *Olmito*, 12 July 1942, 942 (Davis, Texas), Olmito, 15 July 1943, R52 (Davis), near Rangerville, 5 May 1946, R3 (Davis, Texas) and R7 (Davis), lower Adams tract, 12 May 1946, R4 (Davis, Texas), resaca 2.5 miles north of Encantada School, 19 May 1946, R5 and R24 (Davis, Texas), northwest of Laguna Vista, 19 May 1946, R6 (Davis), San Benito, 19 May 1946, R27 (Davis), at large drainage arroyo on river plain south of Alamo showing color variation in flowers, 25 May 1946, R2 (Davis, Texas), six miles south of Barreda, 31 May 1946, R18 (Davis, Texas), near Southmost, 2 June 1946, R22 (Davis) and R23 (Davis, Texas), bank of Cuates Resaca just east of Barreda, 16 June 1946, R13 (Davis, Texas), Brownsville, 23 June 1946, R1 (Davis, Texas, San Benito, 23 June 1946, R20 (Davis, Texas), near Brownsville, 23 June 1946, R21 (Davis, Texas), fish hatchery at Brownsville, 23 June 1946, R19 (Davis, Texas) and R26 (Davis); 6 miles northwest of Brownsville, 5 July 1941, *Davis* 48 (Texas); dense undergrowth by estuary in the vicinity of Brownsville, 1-5 August 1921, *Ferris and Duncan* 3116 pp. (MBG, NY); along roadside about ten miles from Port Isabel, 3 May 1940, *Lundell and Lundell* 8656 (Gray, SMU, US); Olmito, 23 October 1927, *Rose and Russell* 24187a (NY); Brownsville, June 1922, *Runyon s. n.* (MBG) and 213 (US), Brownsville, November 1922, 213 (Texas), Brownsville, November 1928, 159 (US), Brownsville City Park, 1 August 1937, 2372 (Texas), on vacant lot in Brownsville, 18 June 1941, 4045 (Runyon, Texas), open clay ground, Brownsville, 25 April 1946, 4186 (Texas), clayish loam on vacant lots in Brownsville, 10 May 1946, 4196 (Texas), on vacant lots, Brownsville, 19 May 1946, 4197 (Texas), clay soil at Washington and 13th streets, Brownsville, 15 June 1946, 4202 and 24 June 1946, 4203 (Texas); sandy loam, Brownsville, 1941, *Shiller* 726 (Tracy) and 1942, 726 (US), heavy sandy loam, Brownsville, 1942, 878 (Texas); clay dunes in Bahia Grande country east of Brownsville, 14 April 1925, *Small and Wherry* 11858 (NY); moist open bottomland, 25 May 1946, *Wagner and Barkley* 16375 (Texas); DE WITT CO.: in sandy loam about 3 miles southeast of Cuero. 12 June 1947, *Rowell and Webster* 2103

(Texas); DIMMIT CO.: in light brown soil at lake, 24 June 1941, *Tharp* 46008 (Texas); FRIO CO.: in full sun on open prairie in red sandy loam, Melon, alt. 650 ft., 11 June 1940, *Leavenworth and Hoogstraal s. n.* (Field); GOLIAD CO.: Goliad, 22 July 1937, *Reed and Cory* 33779 (Tracy); Goliad, 1 June 1926, *Williams* 39 (Phila); HARRIS CO.: wet soils, Houston, 8 April 1872, *Hall* 427 pp. (Gray); HIDALGO CO.: 28 December 1946, *Albers* 46371 (Texas); Santa Ana Tract, 27 January 1946, *Davis* R38 (Davis, Texas), and 5 May 1946, R16, R17 (Davis), near Mercedes Pump, 12 May 1946, R25 (Davis, Texas), Santa Ana Tract, 26 May 1946, R12 (Davis, Texas) and 14 July 1946, 276-294, and 296-309 (Davis); railroad track between San Juan and Alamo, 20 July 1942, *Walker* 1 (Texas); scrubland eight miles west of Santa Maria, 25 May 1946, *Wolcott and Barkley* 16T368 and 16T369 (Texas); JIM WELLS CO.: Alice, 7 June 1935, *Cory* 14223 (Gray, Texas); sandy soil fifteen miles north of Falfurrias, 24 May 1946, *Wolcott and Barkley* 16T331 (Texas); KINNEY CO.: West Fork of Nueces River, 24 September 1939, *Cory* 33477 (Gray); creek bank ten miles east of Bracketville, 20 August 1947, *Tharp and Brown* 47453 (Texas); ten miles east of Bracketville under highway bridge, 12 October 1940, *Warnock* W840 and W849 (Texas); LA SALLE CO.: on bank of Rio Frio at Fowlerton, 30 July 1921, *Ferris and Duncan* 3040 (NY); in dense shade in sandy bottom along creek, at Artesia Wells, 12 May 1946, *Stern, Barkley and Rowell* 14 (Texas); MAVERICK CO.: eighteen miles southeast of Eagle Pass, 27 July 1935, *Cory* 14352 (Gray); NUECES CO.: sparsely wooded bottom in black soil near Petronilla Creek, 26 May 1946, *Wolcott and Barkley* 16T394, 16T395 pp., 16T397, 16T398 pp. (Texas); STARR CO.: ten miles north of Rio Grande City, 28 July 1947, *Tharp* 47457 (Texas); UVALDE CO.: shaded banks of Leona River seven miles southeast of Uvalde, 23 June 1935, *Munz* 13293 (Calif); dry open ground, Sabinal, 8 June 1916, *Palmer* 10132 (MBG, US), along dry ditches, Uvalde, 18 June 1917, 12286 (MBG, RMt); VAL VERDE CO.: San Felipe Creek, Del Rio, 19 June 1929, *Cory* 3489 (Gray), San Felipe Country Club, Del Rio, 28 July 1934, 9015 (Gray) and Del Rio, 16 August 1942, *Cory* 38075 (Gray); five miles west of Del Rio, 20 August 1947, *Tharp and Brown* 3358 (Texas); VICTORIA CO.: Guadalupe, September 1879, *Palmer* 1006 (Gray); WEBB CO.: wet places near Laredo, August 1899, *MacKenzie* 38 (MBG, RMt, US); forty miles north of Laredo, 18 April 1925, *Wherry s. n.* (US); WILSON CO.: Sutherland Springs, 23 July 1944, *Cory* 45231 (Texas); ZAVALA CO.: eleven miles south of Uvalde, 24 October 1934, *Cory* 11956 (Gray) and four miles southwest of Crystal City, 30 May 1938, 29427 (Gray).

NEW MEXICO.—DONA ANA CO.: in valley below Dona Ana, *Parry, Bigelow, Wright and Schott* 721 pp. (Phila, US).

MEXICO: Walnut Grove, 27 May 1847, *Gregg s. n.* pp., west of Cerralbo, 24 May 1847 *s. n.* and Rinconada, 24 May 1847, *s. n.* (MBG).

TAMAULIPAS: alt. 600 ft., low open woods, hacienda Santa en Gracia, 26 July 1939, *Chase* 7602 (Ariz, Field, Gray); San Fernando, 1 November 1927, *Rose and Russell* 24319 (US); Bravo del Norte: Las islitas near Presidio de San Juan, *Schott s. n.* (Field).

NUEVO LEON: Villa Vista, alt. 540 m. May 1911, *Abon C.* (6) *and Arsène* 6184 (MBG, US); bottomland by small stream about a mile north of Sabinas Hidalgo, 9 June 1947, *Barkley and Barkley* 17M318 (Texas); 20 miles south of Laredo along the highway, 22 June 1935, *Drushel* 9831 (MBG) and 9832 (US); sandy loam bottom two miles north of Sabinas Hidalgo, 26 March 1944, *Heard, Webster and Barkley* 14566B (Texas); valley of Monterrey, 3 August 1889, *Pringle* 2638 (Field); by stream 30 miles southwest of Nuevo Laredo, 12 July 1946, *Stern, Barkley and Rowell* 16M604 (Texas); alt. 1000 ft., near Rio Ramos, 20 km. northwest of Montemorelos, 17 June 1942, *Weaver* 649 (Gray).

COAHUILA: 11 miles south of Allende under trees along a wash on road from Piedras Negras south to Monclova, 22-24 August 1938, *Johnston* 7021 pp. (Gray); Sabinas, 21 May 1902, *Nelson* 6760 (Gray) and 6160 (6360) (US); Valley of Monterrey, 3 August 1889, *Pringle* 2638 (IBM); 4 miles east of Monclova, elev. 2000 ft., 5-7 July 1939, *White* 1711 (Ariz, Gray).

White 1711 (in Herb Ariz.) from Coahuila has much longer leaves and when further material is available this may prove to be varietally distinct.

10a. **Ruellia Runyonii** var. **Berlandieri*** Tharp and Barkley, VAR. NOV.

Herbacea perennis caulescens; caule dense pilosulo, 30-45 cm. alto; foliis dense pilosulis, late lanceolatis, subacutis, subcuneatis; inflorescentii terminalibus, angustis; corollis 3.5-4 cm. longis; capsulis 13-15 mm. longis, dense glanduloso-puberulentis.

Plant perennial, herbaceous or often subligneous at the base, 30-45 cm. tall, nodes 2-6 cm. long, often with a single leafy branch from one or more of the lower or middle nodes, branches ascending; cleistogamous flowering branches often opposite leafy branches; basal internodes subterete, pilosulous but with fine cystoliths evenly and densely distributed, upper internodes obtusely quadrangular and grooved between the angles, densely pilosulous and eglandular to the inflorescence; leaves broadly lanceolate, petioles of upper leaves about 1 cm. long, margin more or less crisped, finely undulate-dentate, apex acute to obtuse, base cuneate and decurrent, 4-5 cm. long, 1.4 to 3 cm. broad, densely pilosulous (but not velvety) beneath, less so above; chasmogamous inflorescence a narrow terminal panicle, branches erect-ascending (except uppermost branchlets sometimes divaricate); pedunculate lateral cymes of 1-3 cleistogamous flowers in the axils of most of the lower and middle leaves; cleistogamous flowers with calyx 10-11 mm. long, eglandular-pilosulous; (corolla lacking having shed); fruit 12 mm. long, about 4 mm. broad, oblanceolate in outline, eglandular-puberulent throughout; chasmogamous flowers with calyx at anthesis 15-18 mm. long, lobes 1 mm. broad at base, subulate-attenuate, densely glandular-pilosulous, distinctly viscid, the corolla a deep bluish-purple, 3.5-4 cm. long, tube 10-12 mm. long, abruptly expanded into the throat; throat 1.5 cm. long, limb about 2.5-3 cm. broad, lobes about 1 cm. long and broad, broadly rounded, tube and throat finely puberulent especially so on the veins; fruits 13-15 mm. long, about 3-4.5 mm. broad, broadest above center, oblanceolate in outline, densely glandular-puberulent throughout, becoming moderately glandular below the apex, not viscid.

Type.—Known only from the the type collection: NUEVO LEON: Diente Canyon, mountains near Monterrey, July 1933, *C. H. and M. T. Mueller* 114 in the Herbarium of the Chicago Natural History Museum no. 710317.

This variety is in many respects superficially similar to *R. Edwardsae* and *R. nudiflora* var. *Mirandae*, but the character of the flowers and fruits place it more closely with *R. Runyonii*.

11. **Ruellia yucatana** (Leonard) Tharp and Barkley, COMB. NOV.

Ruellia nudiflora var. *yucatana* Leonard, Jour. Wash. Acad. Sci. 17: 518. 1927.

Herbaceous perennial with clustered, tough, slender, fibrous-fusiform roots; stems 1-3.5 dm. tall, from a subligneous base, usually several, more or less branched at base, the central branches erect, the marginal ones spreading-ascending, more or less densely clothed with coarse white crooked hairs below,

* See page 5.

Fig. 24.—*Ruellia Runyoni* Tharp and Barkley var. *Berlandieri* Tharp and Barkley. Type.

densely glandular-pilosulous and viscid toward and especially in the inflorescence, elongated internodes (exclusive of the inflorescence) usually 2 (sometimes 1 or 3); basal leaves radially spreading, clustered from crowded nodes, the baldes ovate to narrowly oblong-ovate or subspatulate, obtusely rounded to rarely acute at apex, 3-13 cm. long, 1.5-8 cm. broad, acuminately narrowed below, the margins finely crenate-serrate to subentire, somewhat crisped, both surfaces sparsely (rarely moderately) hirsutulous to glabrate, the petioles rarely more than 2.5 cm. long, usually shorter; stem leaves similar to basal ones but usually smaller, more abruptly contracted below and having shorter petioles; cleistogamous cymes usually several-flowered, on conspicuous, slender, horizontal-upcurved or ascending dichotomous branches, with only an occasional (3rd) flower in the forks, the calyx lobes at anthesis 4-9 mm. long, filiform-subulate, moderately to densely white pilosulous-glandular with pale to yellowish-brown viscid glands; corolla 3.5-4.5 mm. long, 1.2 mm. broad, more or less constricted at middle, slightly swollen above base, the lobes .6 mm. long, triangular; anthers oblong, hastate at base, .5-1 mm. long, the filaments about as long as the basal anther lobes; ovary 2 mm. long, ovoid, pilosulous at apex; style 1-1.3 mm. long, apically recurved; stigma triangular-acuminate, .5 mm. long, the shorter lobe obscure, ovules 4-6 in each cavity; chasmogamous flowers in open or somewhat congested terminal panicles, intermixed with a varying number of cleistogamous ones, the calyx lobes 7-13 mm. long, .5 mm. broad at base, linear-attenuate, densely pilosulous with spreading viscid gland-tipped hairs, scarcely united (1 mm.) at base; corolla lavender-blue (but may turn purplish-red in press), 3-4 cm. long, the tube 6-8 mm. long, 1.5 mm. thick, throat 15 mm. long, 12-15 mm. broad at lobe-bases, lobes orbicular about 1 cm. long and broad, sharply but finely erose to subentire, rounded to retuse; stamens inserted at mouth of corolla tube, longer filaments 8-10 mm., shorter 5-7 mm. long, anthers 2 mm. long, oblong, the bases sub-sagittate; style 12-15 mm. long, obscurely short-hispidulous toward base; stigma 1-1.5 mm. long, linear-lanceolate to linear-oblong, the receptive inner surface concave, papillose, the short lobe an almost obsolete blunt cusp; ovary oblong, 2.5-3 mm. long, densely puberulent, the upper half glandular, the cartilaginous base .7 mm. high, slightly obconic; ovules 7-10 in each cavity; capsules from cleistogamous flowers 10-14 mm. long, exceeding the calyx, 3-3.5 mm. thick, thickest at or slightly above the middle, moderately retrorse-puberulent except the apex which is spreading-glandular-pubescent; capsules from expanding flowers 15-17 mm. long, 3-3.5 mm. thick, thickest in middle, tapering at both ends, rather densely retrorse-puberulent except at apex, which has spreading sparsely glandular pubescence; seeds light yellowish-brown, orbicular, slightly plump, 2-2.5 mm. in diameter, pale to white margined.

Type.—Open grounds near Izamal, Yucatan, 1895, *G. F. Gaumer* 759 in the U. S. National Herbarium no. 268387.

Distribution.—Southern Texas to Yucatan.

Specimens examined.—TEXAS: rich soil, September and October, *Eaton* (NY); *Lincecum and Buckley s. n.* pp. (Phila); 1850, *Thurber s. n.* (Field); western Texas to El Paso, May-October 1849, *Wright* 431 pp. (NY); CAMERON CO.: Fish Hatchery, 23 June 1936, *Davis* R26 (Davis), Southmost, July 1941, s.n. (Davis, Texas), east of Rio

Hondo near South Cayo Atascosa, 30 August 1942, R39 (Davis), Laguna Vista, July 1943, 412 (Davis, Texas), Southmost, 30 September 1944, *s. n.* (Davis, Texas), Port Isabel, 16 September 1945, R42 (Davis, Texas), Southmost, 7 October 1945, R40 (Davis, Texas), Old Cannon Resacca, 21 October 1945, R41 (Davis), Walker's Lake near La Joya, 21 November 1945, s. n. (Davis), near Brownsville, 19 May 1946, R28 (Davis, Texas), northwest of Laguna Vista, 19 May 1946, R29 (Davis), and Olmita, 9 June 1946, R14 (Davis); Rio Hondo, September 1913, *Chandler* 7053 (Calif, Gray, MBG, NY, US); vicinity of Brownsville, 1-5 August 1921, *Ferris and Duncan* 3116 pp. (Calif, NY); Santa Maria, 1889, *Nealley* (170) 358 (Field, US); Olmito, 23 October 1927, *Rose and Russell* 24187 (Gray, NY, US) and 24187a pp. (US); Rabb's Ranch, Palm Grove, 6 November 1923, *Runyon* 588 (US), open grounds, Brownsville, 15 October 1936, 3255 (Runyon), clay loam, open ground and fields on a vacant lot on

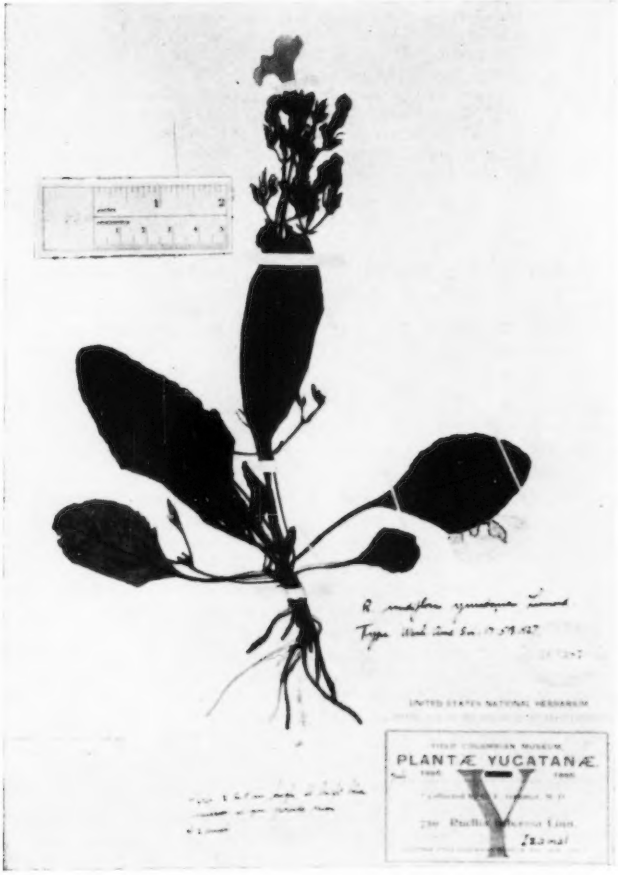


Fig. 25.—*Ruellia yucatana* (Leonard) Tharp and Barkley. Type. See also fig. 12.

Levee Street, Brownsville, 20 May 1946, 4200 (Texas), clay soil at Rio Hondo, leaves broad and viscid, 24 June 1946, 4204 (Texas), Brownsville, 25 October 1946, 4228 (Texas), 810 St. Charles Street, Brownsville, 10 November 1946, 4231 (Texas) and on vacant lot in west Brownsville, 12 November 1946, 4233 (Texas); near Brownsville, 29 April 1895, *Townsend* 28 (US); COLORADO Co.: Eagle Lake, October 1930, *Biology Class* 12 (Texas); DALLAS Co.: low, rich lands, Dallas, August, *J. Reverchon* (*Curtiss'* 1945) (Calif); DUVAL Co.: north of Crestonia, 19 September 1943, *Barkley* 13808 (Calif, Texas); 25.6 miles north of San Diego, 9 October 1935, *Cory* 17224 (Gray); San Diego, 1885-1886, *Croft* 150 (NY); Alice to San Diego, 19 April 1931, *Tharp s. n.* (NY); HARRIS Co.: Cypress, 1906, *Snyder s. n.* (Calif); HIDALGO Co.: 1 mile southwest of La Feria, 13 November 1940, *Cory s. n.* (Gray); dry soil of chaparral at Tabasco, 12 miles west of Mission, 10 July 1933, *Clover* 92 (NY); Edinburg, 1928, *Hooker s. n.* (Texas); by irrigation ditch ten miles west of Santa Maria in sandy loam soil, 2 May 1946, *Wolcott and Barkley* 16353 (Texas); JIM WELLS Co.: 24 May 1946, *Wolcott and Barkley* 16T331 (Texas) KIMBLE Co.: Junction, 2 July 1933, *Whitehouse s. n.* (Texas); KLEBERG Co.: Kingsville, 2 May 1934, *Pope s. n.* (Texas); Kingsville, 1940, *Sinclair* 46010 (Texas); Kingsville, 20 April 1905, *Tracy* 9183 (Field, Gray, MBG, Nebr, NY, Texas, US); SAN PATRICIO Co.: sandy soil on shore of Lake Corpus Christi, 13 June 1947, *Webster and Rowell* 7082 (Texas); UVALDE Co.: fertile open ground along small stream near Uvalde, 28 April 1928, *Palmer* 33585 (MBG, NY); VAL VERDE Co.: Del Rio, elev. 750 ft., 22-23 April 1903, *Pilsbry s. n.* (Phila); WEBB Co.: Laredo on the Rio Grande, August 1879, *Palmer s. n.* (Gray).

MEXICO: Cerralbo, 29 May 1867, *Gregg s. n.* (NY), west of Cerralbo, 24 May 1847, *s. n.* pp. (MBG), Rinconada, 24 May 1847, *s. n.* pp. (MBG), and Walnut Grove, 27 May 1847, *s. n.* pp. (MBG).

TAMAULIPAS: very abundant in mesophytic Cordia-Acacia association between Ciudad Victoria and Monterrey, 30 August 1947, *Barkley, Webster and Paxson* 865 (Texas) near Limon about 73 miles south of Ciudad Victoria, 27 May 1939, *Frye and Frye* 2663 (Calif, Gray, MBG, NY, US); alt. 480 m., understory of thorn forest at Rio del Pilno, 6 October-3 November 1940, *Grant* 502 (Gray); about 13 miles south of Ciudad Victoria, 2 July 1940, *Hitchcock and Stanford* 6884 (Gray, RMt); east of Morales, 12 February 1939, *LeSueur* 454 (Texas); San Fernando to Jimenez, 26-27 February 1902, *Nelson* 6605 (US); alt. 320 m., vicinity of Victoria, 1 May-13 June 1907, *Palmer* 436 (Field, Gray, NY, US), and alt. 15 m., Tampico, 10 March-19 April 1910, 172 (Gray, US); Jaumave, April 1930, *Viereck* 324 (US); Buena Vista Hacienda, "Trenadora," 21 June 1919, *Wooten s. n.* (US).

NUEVO LEON: pine woodlands on Chipinque, 1 July 1947, *Barkley, Webster and Rowell* 7134 and in desert scrub seventeen miles east of Monterrey, 1 July 1947, 7159 (Texas); Monterrey, *Edwards s. n.* (NY); east of Matamoros, 25 October 1927, *Rose and Russell* (Gray, NY, US).

QUINTANA ROO: in savanna, Coba, June-July 1938, *Lundell and Lundell* 7841 (SMU).

YUCATAN: Chichankanab, *Gaumer* 1801 (US), 1895, 488 (US), Izamal, July 1895, 759 (US), and 1917-1921, 24218 (US); frequent in open areas, El Paso, Peten, 20 April 1932, *Lundell* 1516 (SMU); near Yokzonoat along roadside, 10 June 1938, *Lundell and Lundell* 7493 (SMU), "cambalyaxnic," abundant in clearings at Chichen Itzá, June-July 1938, 7597 (SMU), and in clearings around Castillo, June-July 1938, 7525 (SMU); in clearing, Chichen Itzá, 7 June 1932, Steere 1016 (SMU); 1896, *Valdez* 23 (SMU, US).

BRITISH HONDURAS: Corozal district, 1931-1932, *Gentle* 178 (SMU).

GUATEMALA.—EL PETÉN: in grassland of aviation field, heavy clay soil over calcareous substratum, 3 July 1942, *Egler* 42312 (SMU).

The *Runyon* 588, *Viereck* 324, and *Ferris and Duncan* 3116 specimens are not typical of the species. *Wooten s. n.* (21 June 1919) shows some similar-

ity to *R. Runyonii. Snyder s. n.* (1906) is probably a hybrid between *R. yucatana* and *R. nudiflora,* while *Biology Class* 12 is possibly a segregate from such a hybrid. There is a question as to the authenticity of the data on *Wright* 431 collection in regard to the specimens of *R. yucatana* which look like the specimens from Brownsville, (See *R. occidentalis* var. *Wrightii* 3b. above). *Runyon* 4204, clay soil at Rio Hondo, Cameron County, Texas, 24 June 1946, is rather atypical of this species in that the stems are scattered along a very slender rhizome, are very finely puberulent and clothed with coarse white crooked hairs below, have obovate to narrowly oblong-obovate leaf-blades, with margins only very slightly crisped, the stem leaves are manifest and similar to the basal ones, the uppermost only having shorter petioles, the tube of the corolla and the style are slightly longer, and the upper half of the capsule is only very sparsely glandular. It seems, even with those differences, best to treat it as an aberrant member of this species.

12. RUELLIA BRITTONIANA Leonard, Jour. Wash. Acad. Sci. 31: 96. 1941.

Cryphiacanthus angustifolius Nees in DC., Prodr. 11: 199. 1847, in part.

Ruellia spectabilis Britt., Ann. N. Y. Acad. Sci. 7: 192. 1893, in part, non Nicholson, Gard. Dict. 3: 334. 1886.

R. malacosperma Small, Man. SE. Fl. 1229. 1933, non Greenman, Proc. Am. Acad. 34: 572. 1909.

R. Tweediana auths., non Griseb., Symb. ad Fl. Arg. 259. 1879.

Stems usually several, 2-10 dm. high, subligneous, angled to subterete, essentially glabrous, subcorymbosely branched at the summit; leaves linear to linear-lanceolate, 8-27 cm. long, .7-2 cm. broad, lowermost leaves acute or subacute, the others acuminate, narrowly cuneate at the base, entire to undulate, glabrous except for cystoliths, petioles 1-2 cm. long; flowering branches in the axils of the upper leaves, cymose, rarely equalling the subtending leaves and bearing three or more flowers; bracts linear; calyx-lobes subrigid, narrowly lance-attenuate, glabrous or essentially so except for pale cystoliths, 5-10 mm. long; corolla lavender, 2.5-4.5 cm. long, tube 8-12 mm. long, limb 2.5-3.5 cm. broad; capsule glabrous, 2-2.5 cm. long, about 4 mm. wide; seed suborbicular, 2-2.5 mm. in diameter.

Type.—Galeotti in herb. Hook. from Xalapa, Mexico.

Distribution.—Native of eastern Mexico; cultivated and established from Florida to Texas.

Specimens examined.—LOUISIANA: TERREBONNE PAR.: in low sandy soil, Houma, 31 August 1913, *Wurzlow s. n.* (US).

TEXAS.—BEXAR CO.: San Antonio, 20 September 1907, *Bush* 864 (MBG); BRAZOS CO.: College Station, 4 August 1941, *Reeves* 981 (US) and 981A (Tracy); CAMERON CO.: Town Resaca, 19 May 1946, *Davis* R50 (Davis); Brownsville, 1942, *Shiller* 879 (US); HARRIS CO.: Houston, 7 October 1934, *Cory* 11330 (Gray); Houston, 24 September 1923, *Thurow* 12 (US); TARRANT CO.: in damp ground near Polytechnic, 10 October 1916, *Ruth s. n.* (US).

MEXICO: Platon Sanchez, April 1910, *Medellin* 20 (IBM).

SAN LUIS POTOSI: alt. 260 ft., Valles, 2 August 1937, *Fisher* 37054 (Ariz,

Gray); ten miles northwest of Tamazunchale along stream bank, 3 July 1940, *Hitchcock and Stanford* 6920 (Gray); wet ledges of river, Micos, 31 July 1891, *Pringle* 5043 (Gray, IBM); gravelly and rocky sand near river near Axtla, elev. 200 ft., 23 June 1942, *Weaver* 658 (Gray).

VERA CRUZ: in the bed of the Calabozo near the colony Wartenberg near Tantoyuca, Huasteca, 1858, *Ervendberg* 109 (Gray); along streams, Tenera, Zacuapan, December 1912, *Purpus* 6162 and Barranca de Panoya, September 1919, 8409 (Gray).

This species, which is widely cultivated in southern United States, while a particularly uniform and easily recognized species, has had a long history of nomenclatorial misinterpretation, which has been summarized by Fernald (Rhodora 47: 7-12. 1945.).

13. RUELLIA MALACOSPERMA Greenm., Proc. Am. Acad. 34: 572. 1909, non Small, Man. SE. Fl. 1229. 1933.

Stems several, 4-8 dm. high, subligneous, obscurely angled, glabrate except very sparsely and obscurely long-hirsute; leaves 5-12 cm. long, 1.2-3 cm. broad, glabrous except for long white hairs on the margins and veins and for cystoliths, acute to acuminate at apex, cuneate at the base and decurrent on the 1-2 cm. long petioles, margins undulate-dentate; flowers on branches borne in the axils of the upper leaves, (cymose) these usually exceeding the subtending leaves and bearing three to six flowers; bracts linear; calyx lobes .7-2 cm. long, subrigid, lance-attenuate, hirsutulous, ciliolate, bearing cystoliths and sparse sessile inconspicuous glands; corolla deep lavender, 4-5.5 cm. long, tube 9-11 mm. long, limb about 4 cm. in diameter; capsule glabrous, 2-2.5 cm. long, brownish, slightly constricted at the base; seed suborbicular, 2 mm. in diameter.

Type.—Lowlands, Tampico, Tamaulipas, Mexico, 30 April 1898, *C. G. Pringle* 6806.

Distribution.—Texas to Vera Cruz and Sinaloa.

Specimens examined.—TEXAS: FAYETTE CO.: near La Grange, 18 September 1937, *Bartley and Pontius* 643 (NY).

TAMAULIPAS: lowlands, Tampico, 30 April 1898, *Pringle* 6806 (Calif, Field, Gray, IBM, NY, US).

NUEVO LEON: one mile south of Villa Santiago on clay loam in dense shade, 14 July 1946, *Rowell, Lind, and Barkley* 16M585 (Texas); in dense shade of tall weeds and a few trees near el Cercado, 14 July 1946, *Salinas, Salinas and* Barkley 16M365 (Texas).

SAN LUIS POTOSI: low bank of Rio Tampaon, municip. El Pujat ,alt. 100 ft., 18 July 1939, *Chase* 7477 (Gray); El Salto, July 1945 *Davis s. n.* (Davis); alt. 1200 ft., Tamasopo, 24 August 1937, *Fisher s. n.* (Ariz, Gray); vicinity of Panuco, 20-25 April 1910, *Palmer* 349 (Gray).

SINALOA: Marathon, Marcutlan, July 1934, *Gonzalez O.* 7280.

14. **Ruellia Parryi** Gray, Syn. Fl. N. Am. 2: 326. 1878.

Dipteracanthus suffruticosus Torr., Bot. Mex. Bound. 122, non Rozb., Hort. Beng.

A shrub from 1 cm. to 4 dm. tall, usually profusely branched from the root, or from exposed rhizomes, branches at first green, then white and in age

gray, retrorsely hirsutulous, internodes shorter than the leaves, stem often branched above, such branches more or less appressed; leaves spatulate, obovate, lanceolate or oblanceolate, hirsutulous and ciliolate on the margin, rounded to acute at apex, cuneate at base, entire, 1-2 cm. long, .4-1.3 cm. broad, petiole 1/4 - 1/3 as long as the blade; peduncles solitary in the axils of the leaves, each peduncle bearing two leaf-like bracts and a solitary flower; calyx lobes flat, lanceolate, abruptly acute, 7-10 mm. long, about 1 mm. wide, puberulent, margins ciliolate; corolla pale lavender, 3-3.5 cm. long, the slender tube about 1.5 cm. long, the limb 1.5-2.5 cm. broad; capsule brownish glabrous, somewhat constricted at the base, about 1 cm. long, 3 mm. broad; seed brownish, flat, ovate, 3 mm. long, 1 mm. wide.

Type.—At Presidio del Norte, *Parry s. n.*

Distribution.—Southeastern New Mexico and west Texas to Nuevo Leon and Chihuahua.

Specimens examined.—TEXAS: western Texas, 1890, *Nealley s. n.* (Field); BREWSTER CO.: 14 miles east of Castolon at the edge of the Chisos Mountains, 7 March 1937, *Cutler s. n.* (Gray); 30 miles south of Marathon along R227, 16 June 1937, *Drushel* 11200 (US); steep rocky slopes below St. Helena Canyon, alt. 595 m., 14 July 1931, *Moore and Steyermark* 3459 (MBG); dry open ground near Oak Canyon, Chisos Mountains, 24 May 1928, *Palmer* 34128 (NY) and dry rocky ground, Chisos Mountains, 26 May 1928, 34203a (Arnold); Presidio del Norte, 7 July 1852, *Parry* 722 (NY); in protection of Lechuguilla near Burnham's ranch, Chisos Mountain area, 27 August 1936, *Sperry* 307 (US) and Lechuguilla areas about 3 miles west of Glenn Spring, 20 August 1939, 1553 (Gray); 9 October 1936, *Tharp* 44510 (Texas); infrequent on rocky hills at Glenn Springs in the Chisos Mountain area, 3 May 1937, *Warnock* 307 (Gray, Iowa, Texas), scattered on limestone ridges of Bissett Mountain in the Glass Mountains, 6 August 1940, W323 (Gray, Texas), 10 miles south of Marathon on Chisos Road, 25 June 1941, 21371 (Texas), rocky hilly slopes 10 miles south of Marathon, 28 June 1941, 20956 (Texas) and north side of Bissett Hill in the Glass Mountains, 3 July 1941, 506 (Gray); infrequent and widespread on rocky limestone slopes of Reagan Canyon 3 miles from the Rio Grande, 24 December 1946, *Warnock and Hinckley* 461075 (Texas); CULBERSON CO.: among boulders and cracks in limestone ledges along arroyo running up northeast slope of Beach Mountain north of Van Horn, 15 June 1943, *Waterfall* 4527 (Gray) and on red sandstone along arroyo and base of canyon in southwestern slopes of Beach Mountain 6.5 miles north of Van Horn, 14 July 1943, 5074 (Gray); HUDSPETH CO.: 25 May 1928, *Cory* 2455 (Gray); calcareous gravelly soil along canyon through igneous cliffs and ledges in the south end of Quitman Mountains six miles northeast of Indian Hot Springs, 1 July 1943, *Waterfall* 4826 (Gray, MBG) and red calcareous gravelly clay along arroyo in south end of the Quitman Mountains 4 miles northeast of Indian Hot Springs, 1 July 1943, 4850 (CalA, Gray, MBG); PRESIDIO CO.: 22 May 1928, *Cory* 2456 (Gray); near Shafter, 26 April 1931, *McKelvey* 2023 (Arnold); calcareous gravel hillsides at the south end of Van Horn Mountains near Porvenir, 26 June 1943, *Waterfall* 4744 (Gray); VAL VERDE CO.: dry rocky hillsiles, Comstock, 9 October 1917, *Palmer* 12960 (Arnold, Calif, MBG).

NEW MEXICO.—EDDY CO.: valley of the Pecos, 1851, *Wright* 1461 (Gray, MBG, NY, Phila); on rocky cliffs, Guadalupe Mountains, 3 May 1941, *Hershey s. n.* (CalA); Carlsbad Cavern, alt. 4400 ft., 25 April 1924, *Lee* 59 (US); bed of small canyon on southern side of Dark Canyon, Guadalupe Mountains, 21 April 1932, *Wilkens* 1539 and among rocks in canyons on north slope near mouth of Dark Canyon, Guadalupe Mountains, 23 April 1932, 1606 (Phila); Dark Canyon, Guadalupe Mountains, alt. 4000± ft., 5 August 1909, *Wooten s. n.* (NM); HIDALGO CO.: Gray's Ranch, Guadalupe Mountains, alt. 4500 ft., 9 August 1939, *Goodding s. n.* (CalA).

NUEVO LEON: 150 miles south of Monterrey, *Artamanoff s. n.* (Field); talc-like

limy soil and shaly limestone eleven miles west of Santa Catarina, 12 July 1946, *Hernandez C., Rowell and Barkley* 16M532 (Texas).

COAHUILA: Sierra Mojada Mountains, 19 April 1892, *Jones* 331 (US); Zacate Muzquiz, 14 July 1936, *Marsh* 512 (Texas); Parras, 112 miles west of Saltillo, 8-28 June 1880, *Palmer* 1008 (Gray, Phila, US) and Saltillo, June 1898, 252 (Gray, US); near El Puerto de San Lazaro, Municipio de Castanos, 16 June 1936, *Wynd and Muller* 103 (Ariz, Arnold, IBM, MBG, NY, US).

CHIHUAHUA: Meoquí, 7 August 1936, *LeSueur* 930 (Ariz, CalA, MBG, Texas); rocky hills near Chihuahua, 10 August 1885, *Pringle* 673 (Arnold, Field, Gray, MBG, NY, Phila, US).

This miniature shrubby *Ruellia* the most distinctive species which we have in the Texas area, is often confused with species of *Siphonoglossa* and *Dyschoriste*, according to whether the leaf shape or the habit is being used in comparison.

15. RUELLIA PEDUNCULATA Torr. ex Gray, Syn. Fl. N. Am. 2: 325. 1878.

Stem 1-7 dm. high, usually slender, firm, subterete or more or less quadrangular, minutely pilose and densely appressed puberulent or less often sparsely hirsute, internodes usually long, sometimes simple but often with spreading to ascending branches; leaves narrowly ovate, or sometimes ovate-oblong or lanceolate, acuminate at apex or rarely subacute, cuneate at the base and decurrent, entire to undulate, the principal leaves 3-11 cm. long and 2-4.5 cm. broad, the lower leaves smaller, obtuse to subacute, and soon deciduous, petiole short; flowers solitary at the tips of simple two bracted peduncles, or cymose with two to several flowers; peduncles straight to somewhat curved, 3-7 cm. long; bracts smaller than, but similar in appearance to, the principal leaves; calyx segments linear-filiform, less than 1 mm. broad at the base, tapering to very slender tips, 1-3 cm. long, hirsute to hirsutulous; corolla blue-violet or sometimes paler, 3.5-5.5 cm. long, the tube about equal to the narrow throat in length, the limb 2-3 cm. broad; capsule hirsutulous, brownish, 1.5-2 cm. long, about 5 mm. broad, constricted for about a third of its length; seeds suborbicular, about 3 mm. in diameter.

Type.—Louisiana, *Hale s. n.*

Distribution.—Southern Illinois, western Louisiana to eastern Oklahoma and Texas.

Specimens examined.—MISSOURI: open hillside a half mile west of Cedar Gap, alt. 1675 ft., 22 May-3 June 1911, *Lansing* 3020 (Iowa, US); St. Francis River, 12 July 1897, *Savage and Stull* 679 (Iowa); BARRY CO.: common in woods, Eagle Rock, 26 May 1895, *Bush* 78 (CalA, US) and 20 September 1896, 155 (KanSt, US); IRON CO.: Ironton, 21 June 1897, *Savage and Stull* 224 (Iowa) SHANNON CO.: Monteer, 9 October 1910, *Bush* 6401 (US).

TEXAS: sandy clay creek bottom, Houston, 2 July 1923, *Wehmeyer s. n.* (KanSt).

ARKANSAS: *Bigelow* (US); Ozark Mountains in northern Arkansas, *Harris s. n.* (Gray); southwestern Araknsas, 20 May 1888, *Pringle s. n.* (RMt); CARROLL CO.: dry open ground, Eureka Springs, 19 September 1913, *Palmer* 4378 (RMt, US); CRAIGHEAD CO.: open sandy soil, Jonesboro, 7 June 1923, *Pennell* 11510 (Phila); FAULKNER CO.: Conway, 10 May 1932, *Haas* 377 (US) and open fields near Conway, 22 May 1932, 1746 (US); FRANKLIN CO.: rocky hillside near Ozark, 29 May 1920, *Pennell* 10622 (Phila); FULTON CO.: dry chert forest at Mammoth Spring, 8 June 1923, *Pennell*

11558 (Phila); GARLAND CO.: Hot Springs, August 1879, *Letterman s. n.* (Gray); scattered on sides of hills near Hot Springs, 9 July 1931, *Runyon* 1439 (US); IZARD CO.: sandstone east of Guion, 1 June 1920, *Pennell* 10692 (Phila); NEVADA CO.: four miles southeast of Prescott, 3 June 1912, *Hollister s. n.* (US); OUACHITA CO.: Camden, *Fendler s. n.* (Gray); PULASKI CO.: elev. 500 ft., rocky wooded ridge near Little Rock, 6 June 1940, *Demaree* 21139 (CalA, Calif, Gray, Okla); Little Rock, 3 June 1887, *Hasse s. n.* (Phila, RMt) and low grounds near Little Rock, May 1885, *s. n.* (US); shale and sandstone above Little Rock, 31 May 1920, *Pennell* 10649 (Phila); SALINE CO.: dry ridges near Benton, elev. 300 ft., 16 May 1942, *Demaree* 22978 (Calif); SEBASTIAN CO.: Fort Smith, 1853-1854, *Bigelow s. n.* (US); WASHINGTON CO.: Mt. Sequoyah, Fayetteville, 2 June 1937, *Beck* 39 (Okla); Fayetteville, 29 May 1927, *Normand s. n.* (Texas); Greenland Township, summer 1939, *Turner s. n.* (Texas); Savoy, 18 May 1921, *Wherry s. n.* (US).

LOUISIANA: *Hale* 159 (Phila); *Steweheuer s. n.* (Phila); JEFF DAVIS PAR.: knolls and low praries, Welsh, 17 May 1915, *Palmer* 7649 (US); NATCHITOCHES PAR.: dry open ground, Natchitoches, 5 May 1915, *Palmer* 7511 (CalA, US); RAPIDES PAR.: Alexandria, June-September, *Hale s. n.* (NY) and 225 (Gray); ST. LANDRY PAR.: dry woods, Opelousas, *Carpenter and Hale s. n.* (US).

OKLAHOMA: CHEROKEE CO.: on dry limestone bluffs and escarpments and steep talus slopes eight miles north of Tahlequah, 7 May 1938, *Hopkins* 3141 (Okla); LE FLORE CO.: six miles north of Poteau in black-jack forest, 22 June 1928, *Barkley* 492 (Okla); in woods near Page, 20 June 1914, *Blakeley* 1423 (Gray, MBG, US); along road west of Ludlow, 8 June 1930, *Little and Olmsted* 182 (Okla); wet sandy oak-hickory woods ten miles south of Ardmore, 22 May 1938, *Hopkins* 3387 (Okla); MCCURTAIN CO.: water-oak-gum association in sand near cypress swamps seven miles southeast of Broken Bow, 16 June 1940, *Hopkins and Waterfall* 2121 (Okla); common in woods near Idabel, 18 May 1916, *Houghton* 3625 (Gray, MBG) and 3638 (Gray, MBG) along road between the Narrows and Smithville, 8 June 1930, *Little and Olmsed* 144 (Okla); mountainsides near Broken Bow, 14 May 1930, *Sears* 1356 (Okla); edge of pine-oak forest one mile south of Smithville, 27 August 1938, *Smith* 906 (Okla); MUSKOGEE CO.: Braggs Mountain, 15 May 1935, *Bebb* 3537 (Okla); rocky wooded hillside, 22 May 1927, *Little* 619 and 701 (Okla).

TEXAS: 13 May 1903, *Reverchon* 116 (MBG..; ANDERSON CO.: Palestine, 19 April 1895, *Plank s. n.* (NY); ANGELINA CO.: Zavala, 15 September 1923, *Tharp* 2676 (Texas); BOWIE CO.: alt. 300 ft., near Texarkana, 29 August 1889, *Heller and Heller* 4171 (MBG, NY, US); Dalby, *Milligan s. n.* (NM) CASS CO.: rocky woodlands, Hughes Springs, 9 May 1903, *Biltmore Herbarium* 10679a (US); CHEROKEE CO.: dry sand ground, Jacksonville, 21 September 1915, *Palmer* 8600 (CalA, MBG, NY, US); FANNIN CO.: Windom, 15 May 1929, *Tharp s. n.* (Texas); HARRIS CO.: Houston, 1917, *Hayden s. n.* (Gray); HARRISON CO.: common in woods, Marshall, 8 October 1901, *Bush* 981 (MBG); HOUSTON CO.: alt. 380 ft., Crockett, 8 May 1932, *Brock* 3243 (Field); MARION CO.: Jefferson, 11 May 1905, *Bebb* 2626 (Okla); NACOGDOCHES CO.: May 1936, *Briggs s. n.* (Texas); PANOLA CO.: in pine land off highway 149 northwest of Carthage, 7 May 1941, *Lundell and Lundell* 10489 (SMU, US); POLK CO.: 14 May 1942, *Tharp s. n.* (Texas); SAN AUGUSTINE CO.: open woods San Augustine, summer, *Crocket s. n.* (US); SMITH CO.: frequent hillside in open oak woods, Camp Fannin eight miles northeast of Tyler, 1 May 1944, *Moore* 751 (Gray) and growing in thin leafmold over red clay base in open oak woodland, Amigo, 13-23 May 1945, 958 (Gray, Texas); sandy woods, Troupe, 8 May 1902, *Reverchon s. n.* (MBG); UPSHUR CO.: sandy woods, Big Sandy, 28 May 1901, *Reverchon* 2535 (2029) (MBG, NY); VAN ZANDT CO.: near Wills Point, spring 1930, *Peckham s. n.* (Texas); WOOD CO.: woods near Golden, 12 June 1927, *McMullen s. n.* (Texas).

Some specimens (*Palmer* 7649) show some similarity to *R. pinetorum*, although for a species in this genus it shows unusual uniformity throughout its range.

16. RUELLIA PINETORUM Fernald, Rhodora 47: 24. 1945.

Stem 1-4 dm. high, slender, subterete or more or less quadrangular, very minutely pilose in lines and puberulent with closely appressed hairs, simple or often with spreading branches, internodes longer than the leaves; leaves oblong, ovate or elliptic-lanceolate, subacute at the apex, broadly cuneate at the base, subsessile, margin usually undulate, the basal leaves small, the principal leaves 2-4.5 cm. long, .5-2 cm. broad; flowers solitary at the tips of two-bracted peduncles or cymose with 2 to several flowers; peduncles usually straight, .2-3 cm. long; bracts lanceolate, shorter than the calyx lobes; calyx lobes linear-filiform, less than 1 mm. broad at the base, tapering to very slender tips, 1.5-2 cm. long, glabrate except for closely appressed hairs or elongated cystoliths; corolla bluish-lavender, 3.5 cm. long, the tube longer than the throat, the limb 2-3 cm. broad; capsule glabrous, brownish, 1.2-1.6 cm. long; seed orbicular, about 3 mm. in diameter.

Type.—Low pine barren, Horry County, South Carolina, 28 July 1936, *F. G. Tarbox* 800 in the United States National Herbarium.

Distribution.—Low pine barrens of the Coastal Plain, South Carolina to northern Florida and eastern Texas, apparently local.

Specimens examined.—LOUISIANA: CALCASIEU PAR.: near Lake Charles, 1904, *Allison* 57 and 297 (US) and vicinity of Lake Charles, 28 May 1904, 261 (US); ORLEANS PAR.: New Orleans, 1832, *Drummond* 259 (Gray); ST. TAMMANY PAR.: Covington, September 1919 *Arsène* 11687 (US).

TEXAS: *Dapprich* 7420 (SMU); ORANGE CO.: Vidor, 29 January 1931, *Wood s. n.* (Texas); WOOD CO.: ooen woods, Golden, 12 June 1927, *McMullen s. n.* (Texas).

A species closely resembling *R. pedunculata* but with several very easily recognized differences. An occasional specimen shows some similarity to *R. humilis* (*McMullen s. n.* and *Dapprich* 7420).

17. RUELLIA STREPENS L., Sp. Pl. 634. 1753, emend. L. Mantiss. Alt. 422. 1771.

Dipteracanthus strepens (L.) Nees, Linnaea 16: 292. 1842.
D. strepens var. *calycinus* Nees in DC., Prodr. 11: 121. 1847.
D. strepens var. *pedunculatus* Nees in DC., Prodr. 11: 122. 1847.
D. strepens var. *strictus* Nees in DC., Prodr. 11: 122. 1847, in part.
Ruellia biflora Balbis ex Nees in DC., Prodr. 11: 122. 1847, in syn.
R. foliosa Schweinitz ex Nees in DC., Prodr. 11: 122. 1847, in syn.
R. oblongifolia Kinn ex Nees in DC., Prodr. 11: 122. 1847, in syn.
R. vincaeflora DC ex Nees in DC., Prodr. 11: 122 .1847, in syn.

Stems herbaceous, one to few from a knotty, short rhizome 2-10 dm. high, simple or with a few ascending branches above, more or less four-angled, minutely appressed puberulent and minutely pilose often only in lines, or glabrate in age; the lowest leaves small, spatulate or obovate, rounded at the apex and cuneate at the subsessile base, the principal leaves membranaceous, ovate, 7-16 cm. long, 3-7 cm. broad, subacute to subacuminate at the apex, entire or undulate, cuneate at the base and decurrent on the short petiole which is less than one cm. long (below the winged portion), minutely ap-

pressed puberulent and usually short-strigillose on both surfaces, minutely ciliolate when young; peduncles ascending, usually short, 2-30 mm. long, usually borne from the axils of 1-3 pairs of median leaves and bearing a pair of lanceolate bracts similar to the foliage leaves in texture and 1-3 showy flowers; calyx-segments lanceolate to lance-linear, 2-4 mm. broad, 1.5-2.5 cm. long, flattened to their tips, villous-ciliate, short-strigillose; corolla pale blue-violet, 4-6 cm. long, the tube about as long as the broadly funnelform throat, limb 2-3 cm. broad; capsule 1.5-2 cm. long, brownish, glabrous, shorter than the calyx lobes; seeds brownish, suborbicular, 1.5 mm. in diameter.

Type.—In the Linnaean Herbarium.

Distribution.—New Jersey to Iowa and Kansas south to South Carolina and eastern Texas, chiefly in basic or calcareous soils in low woods, bottomlands, or wooded swamps.

Specimens examined.—On route from Leavenworth to El Paso, *Diffenderffer s. n.* (Phila).

IOWA.—APPANOOSE CO.: woods east of Moravia, 11 June 1902, *Smimek and Euers s. n.* (Iowa); DECATUR CO.: wooded slopes, Moran Township, southwest part of county, 12 June 1902, *Shimek s. n.* (Iowa); HENRY CO.: Mount Pleasant, 4 June, *Mills* 614 and 617 (Iowa).

MISSOURI: DAVIES CO.: dry banks, Pattonsburg, 24 May 1935, *Bush* 13587 (KanSt, Texas); JACKSON CO.: common on the prairie, Westport, 9 July 1896, *Bush* 834 (KanSt); MARION CO.: Scipio landing near Hannibal in damp rich soil, 16 June 1916, *Davis s. n.* (Nebr); ST. LOUIS CO.: Meramac Highlands, 13 June 1909, *Ohlweiler s. n.* (Texas).

ARKANSAS: *Pitcher* (Phila); PULASKI CO.: swampy Arkansas River bottoms, Little Rock, elev. 350 ft., 8 May 1938, *Demaree* 17321 (Okla); Little Rock, May 1885, *Hasse s. n.* (KanSt); WASHINGTON CO.: Greenland Township, summer 1939, *Turner s. n.* (Gray).

KANSAS: *Fairchild s. n.* (KanSt); BOURBON CO.: 11 August 1897, *Clothier and Whitford s. n.* (KanSt); CHAUTAUQUA CO.: Sedan, 20 May 1897, *Gilette s. n.* (KanSt); CHEROKEE CO.: May 1896, *Hitchcock s. n.* (KanSt); COFFEY CO.: 31 August 1897, *Clothier and Whitford s. n.* (KanSt); COWLEY CO.: May 1898, *White s. n.* (KanSt); CRAWFORD CO.: August 1939, *Ross* 170 (KanSt); DOUGLAS CO.: 7 August 1899, *Hitchcock s. n.* (KanSt); ELK CO.: 20-21 August 1897, *Clothier and Whitford s. n.* (KanSt); FRANKLIN CO.: July 1896, *Hitchcock s. n.* (KanSt); GEARY CO.: June 1896, *Hitchcock s. n.* (KanSt); GREENWOOD CO.: Eureka, July 1892, *Hitchcock s. n.* (KanSt); JEFFERSON CO.: Perry, 12 October 1896, *Clothier s. n.* (KanSt); LOBETTE CO.: Chetopa, August 1892, *Hitchcock s. n.* (KanSt); MONTGOMERY CO.: August 1896, *Hitchcock s. n.* (KanSt); RILEY CO.: Manhattan, *Kellerman s. n.* and Manhattan, 31 May 1887, *s. n.* (KanSt); low woods, 1 June 1895, *Norton* 387 pp. (Gray, KanSt, NM); SALINE CO.: common in woods near Military School, June 1930, *Hancin* 1022 and along Saline River northwest of New Cambria, 31 August 1930, 703 (KanSt); SHAWNEE CO.: Topeka, May 1895, *Smyth* 3371 (KanSt); WYANDOTTE CO.: common in low woods, 30 May 1897, *Mackenzie s. n.* (KanSt).

OKLAHOMA.—CHEROKEE CO.: in deep ravine of Illinois River Park, 25 May 1940, *Bebb* 5329 (Okla); CLEVELAND CO.: four miles east of Norman in damp lowland, 27 May 1928, *Barkley* 245 (Okla); very rich bottom land in a large grove, 17 May 1940, *Hawk* 7 (Okla); CREEK CO.: Sapulpa, 2 June 1924, *Williams s. n.* (Gray, MBG, Phila, RMt); JOHNSON CO.: moist rich woods and open railway right-of-way two miles south of Mill Creek, Hunton limestone and Woodford Chert formations, 29 May 1940, *Hopkins* 4871 (Okla); KAY CO.: in woods near Tonkawa, 5 August 1913, *Stevens* 1869 (Gray); LATIMER CO.: woods in river bottoms east of Gowen, 12 June 1930, *Clark* 2736

(Okla); LE FLORE CO.: low woods, Poteau, 13 July 1915, *Palmer* 8275 (CalA, US); LOGAN CO.: rich shaded soil eleven miles northwest of Guthrie, *Smith s. n.* (Okla); MCCURTAIN CO.: bottoms by big Taxodium near Broken Bow, 16 May 1936, *Demaree* 12602 and 12649 (Okla); floodplain and cypress swamp at Little Creek, Eaglestown, 19 May 1939, *Hopkins and Van Valkenburgh* 4186 (Okla); river bottom near Garvin, 15 May 1930, *Sears* 1448 (Okla); MURRAY CO.: in canyon of Arbuckle Mountains, 27 May 1939, *Bebb* 4153 (Okla); Davis, 1 July 1916, *Emig* 683 (MBG); Platt National Park, 14 May 1935, *Merrill and Hagan* 411 (Okla) and 445 (Field); MUSKOGEE CO.: in shady ravine, 24 May 1940, *Bebb* 5529 (Okla); 26 August 1927, *Little* 2590 (Okla); OKLAHOMA CO.: moist clay soil, wooded creek bottom about six miles west and three miles north of Edmund, 19 May 1940, *Waterfall* 1975 (Gray, Okla); POTTAWATOMIE CO.: in small valley, St. Louis, 16 May 1936, *Faulkner* 106 (MBG, Okla); SEQUOYAH CO.: damp, shaded ground near the mouth of the Illinois River, 13 May 1934, *Goodman and Barkley* 2131 (Gray, MBG, Okla).

TEXAS: *Drummond* 259 (Gray); Gurley, 20 April 1907, *Howell* 363 (US); shade, Coomb's Branch, 21 May, *Reverchon* 726 (MBG); San Antonio to Houston, 15 September 1877, *Ward s. n.* (US); *Wright s. n.* (Gray); BRAZOS CO.: six miles west of Wellborn, 5 May 1941, *Reeves* 1429 and brushy creek, McCullough Ranch, 28 April 1943, 2010A (Tracy); 1 May 1939, *Taber* 1897 (Tracy); BRAZORIA CO.: 21 August 1938, *Tharp s. n.* (Calif); DALLAS CO.: in shade, 6 May 1905, *Bebb* 2450 (Okla); moist woodlands, Dallas, 15 May 1903, *Biltmore Herbarium* 4500b (US); Bluff View, 13 April 1925, *Hynes s. n.* and 1926, *s. n.* (Texas); in woods along White Rock Creek north of Vickery, 31 May 1940, *Lundell and Lundell* 9199 (US) and perennial in woods along creek north of Vickery, 4 June 1940, 9263 (Gray, SMU, US); woods, Dallas, 26 May 1874, *Reverchon s. n.* (MBG); vicinity of Dallas, 3 May 1929, *Stephenson* 91 and 10 May 1929, 94 pp. and 95 (US); DENTON CO.: moist alluvial shade, 20 May 1931, *Harris s. n.* (NTex); FANNIN CO.: Windom, 15 May 1929, *High School* (Texas); FORT BEND CO.: Richmond, 21 April 1899, *Bray* 118 (US); GRAYSON CO.: Denison, 9 May 1932, *Mason* 21 (Texas); TARRANT CO.: sandy woods, 1927, *Killian* 6974 (Texas, US); Reunion, July 1876, *Reverchon s. n.* (Field); plains, Fort Worth, 17 July 1909, *Ruth* 103 (US); rocky hills, Fort Worth, 7 May 1910, 233 (Texas) and in damp woods Lake Worth, 3 September 1920, 318 pp. (Field, KanSt, Phila, US); Forth Worth, May 1894, *Schneck s. n.* (Field); VAN ZANDT CO.: Wills Point, 13 May 1931, *Johnson s. n.* (Texas); WALLER CO.: Pattison, 14 May 1930, *Muske s. n.* (Texas).

Ward s. n. is somewhat atypical of the species, and *Tharp s. n.* (Brazoria County, Texas) approaches var. cleistantha.

17a. RUELLIA STREPENS var. CLEISTANTHA Gray, Syn. Fl. N .Am. 2: 327. 1878.

Ruellia strepens f. *cleisantha* (Gray) S. McCoy, Am. Bot. 43: 24. 1937.

Dipteracanthus micranthus Engelm. and Gray, Bost. Jour. Nat. Hist. 5: 49. 1845.

Hygrophila illinoiensis Wood ex A. Gray, Syn. Fl. N. Am. 21: 327. 1878. erroneously assigned to Bull. Torr. Club 5: 41. 1874.

Ruellia strepens var. *micrantha* (Engelm. and Gray) Britt., Mem. Torr. Bot. Cl. 5: 300. 1894.

Stems herbaceous, one to few from a knotty rhizome, 2-12 dm. high, simple or with a few ascending branches, more or less four-angled, minutely appressed-puberulent and sometimes minutely pilose or glabrate; the lowest leaves small and soon deciduous, the principal leaves narrowly to broadly ovate, acute to acuminate, cuneate and decurrent on short petioles, 6-17 cm. long, 1.5-6 cm. broad, minutely appressed-puberulent and often short-strigillose; peduncles

ascending, short, .3-2 cm. long, bearing a pair of ovate to lanceolate leaf-like bracts and a cluster of several (rarely 1) cleistogamous flowers or rarely with a somewhat or fully expanded flower; calyx lobes lanceolate, 2-4 mm. broad, 1-2 cm. long, flatened to their tips, villous-ciliate and usually short-strigillose, usually densely appressed-puberulent; corolla closed-tubular, pale-creamy, about 7 mm. long (but sometimes expanding, pale blue-violet, 2-6 cm. long); capsules abundant, light brownish, 1-1.5 cm. long, about 4 mm. broad; seed elliptical or suborbicular, 2.5-3.5 mm. in diameter.

Type.—St. Louis, Missouri, Sept. 1845, *G. Engelmann* in Gray Herbarium.

Distribution.—Pennsylvania to Virginia westward to Iowa, Kansas, and Texas.

Specimens examined.—MISSOURI: ST. LOUIS CO.: Creve Coeur Lake, 6 October 1889, *Hitchcock s. n.* (KanSt).

ARKANSAS.— LAFAYETTE CO.: alt. 300 ft., Spirit Lake, 18 August 1898, *Heller and Heller* 4118 (Calif, Field, Gray, Nebr, Phila, RMt, US); MARION CO.: White River bottoms near Flipin, 2 August 1939, *Demaree* 20642 (CalA, Gray); PULASKI CO.: common, rocky wooded bottoms, Little Rock, 28 September 1931, *Demaree* 8282 (Gray, US), woods of Arkansas River bottoms, natural steps, 15 September 1931, 8678 (US) and Palarm Creek near Arkansas River on Border of Faulkner County in damp shady places, 21 October 1931, 8678 (Calif); SALINE CO.: bottoms of Saline River at Benton, 10 October 1931, *Demaree* 8491 (US).

KANSAS.—ALLEN CO.: July 1896, *Hitchcock s. n.* (KanSt); ANDERSON CO.: July 1896, *Hitchcock s. n.* (KanSt); ATCHISON CO.: Atchison, September 1892, *Hitchcock s. n.* (KanSt); BUTLER CO.: 27 August 1897, *Clothier and Whitford s. n.* (KanSt); CLAY CO.: Clay Center, 1929, *Weber* 150 (KanSt); GEARY CO.: in the wooded bank south of Shiskey Lake, Jefferson township, 3 October 1935, *Gates* 18686 and in woods along McDowell Creek at K13 in Jackson township, 13 October 1935, 18763 (KanSt); 28 September 1896, *Hitchcock s. n.* (KanSt); RILEY CO.: in woods along Wildcat Creek, 18 September 1926, *Gates* 14496 (KanSt); low woods, 1895, *Norton* 387 pp. (Gray); SEDGWICK CO.: Wichita, September 1919, *Rife* 179 (KanSt); WABAUNSEE CO.: 23 August 1896, *Hitchcock s. n.* (KanSt); WILSON CO.: Roper, 26 August 1896, *Haller s. n.* (KanSt); WOODSON CO.: south of Yates Center, 16 October 1928, *Rogers s. n.* (KanSt).

OKLAHOMA.—CREEK CO.: Sapulpa, rare, 31 July 1894, *Bush* 430 (MBG); JOHNSON CO.: open woods near Tishomingo, October 1915, *Houghton* 3342 (Gray, MBG); KAY CO.: in woods near Tonkawa, 5 August 1913, *Stevens* 1869 (MBG, US); LE FLORE CO.: low woods, Poteau, 13 July 1915, *Palmer* 8275 (MBG); MURRAY CO.: deep rich woods in the Woodford Chert formation near the Goldby Settlement in the Arbuckle Mountains, 21 September 1940, *Hopkins and Van Valkenburgh* 5438 (Okla); Buffalo spring near Sulphur, Platt National Park, 20 August 1935, *Merrill* 1208 (MBG); Platt National Park, 20 August 1935, *Merrill and Hagan* 1208 (Okla); thickets along creek, Arbuckle Mountains near Davis, 9 October 1937, *Palmer* 44010 (MBG); MUSKOGEE CO.: 4 September 1927, *Little* 2216 and 11 September 1927, 2736 (Okla); OKLAHOMA CO.: moist clay soil, open woods along creek bottom through prairie near Edmund, 29 August 1940, *Waterfall* 2419 (Calif, Okla); OSAGE CO.: near Skiatook, 16 September 1937, *Engleman* 336 (Okla); OTTAWA CO.: black loam soil, 6.5 miles east of Miami, 21 September 1940, *Kennedy* 23 (Calif); PAYNE CO.: red loam soil two miles north of Stillwater, 18 September 1940, *Blevins* 90 (MBG); sandy loam soil two miles north of Stillwater, 4 October 1934, *McClary* 71 and 72 (Okla); ROGERS CO.: Verdigris, common, 2 August 1894, *Bush* 429 (MBG).

TEXAS.—*Drummond* 202 (Gray, NY); July 1884, *Lindheimer* 290 (Gray, MBG, Phila, US); *Pich s. n.* (US); BRAZORIA CO.: common in woods, Columbia, 5 October 1900, *Bush* 1342 (MBG); 21 August 1938, *Tharp s. n.* (Gray, MBG, SMU, Texas); BRAZOS CO.: near small stream in woods on Highway 6 one mile south of College Sta-

tion, 3 August 1940, *Reeves* 164 (US) and 164A (Tracy); DALLAS CO.: woods, Dallas, 1880, *Reverchon s. n.*, thickets, Buzzard Spring, 1 August 1902, *s. n.* and rich woods, 727 (132) (MBG); near Dallas, 22 June 1929, *Stephenson* 94 pp. (US); JACKSON CO.: Lavaca River, 29 August 1941, *Tharp s. n.* (Calif, Gray); TARRANT CO.: 1927, *Killian s. n.* (Texas); in valley of the Trinity, rich woods, 10 September 1921, *Ruth* 318 pp. (CalA, Field, KanSt, NY, Phila, US); Fort Worth, 9 September 1877, *Ward s. n.* (US); WHARTON CO.: San Bernard, 28 June 1923, *Tharp* 2666 (Texas, US); Wharton, 15 July 1933, *Whitehouse s. n.* (Texas).

The status of this plant in relation to the species is still questionable, some believing that it represents only a later phase in the season than the species, and others believing that it is usually represented by plants other than those of the species. With many differences between the two groups of plants, even though individual specimens may show both the chasmogamous and the cleistogamous inflorescences, it seems best to the authors to continue to consider this a separate variety.

18. RUELLIA CILIOSA Pursh, Fl. Am. Sept. 2: 420. 1814.

Dipteracanthus ciliosus (Pursh) Nees, Linnaea 16: 294. 1842, non Nees in DC., Prodr. 11: 122. 1847.

Ruellia humilis Small, Fl. SE. U. S. 1084. 1903, non Nutt., Trans. Am. Phil. Soc. 5: 182. 1837.

Perennial; a copiously villous hirsute rosulate plant with abbreviated or elongated axis from .5-30 cm. high (in the elongated plants the uppermost pairs of leaves remote, the stem often divergently branched, especially at the base); lowermost leaves oblong, oblong-obovate or oblong-lanceolate to lance-spatulate, the apex subacute to more often rounded, prolonged into subsessile cuneate bases, the larger 2-10 cm. long, 1-3 cm. broad, the upper leaves often longer and narrower and with definite petioles, margins undulate, copiously white villous-hirsute; flowers mostly solitary in the axils, sessile or pedunculate, the short peduncle villous-hirsute and terminated by two more or less lanceolate bracts of similar texture to the leaves; calyx-segments linear-aciculate, villous-hirsute on the outer surface and with cystoliths; corolla bluish-lavender to nearly white, 3.5-7 cm. long, the slender tube 1.5-4 cm. long, the expanded limb 3-4 cm. broad; capsule glabrous, brownish, 1.5 cm. long, 3 mm. broad; seeds suborbicular, about 3 mm. in diameter.

Type.—Near Savannah, Georgia, July, in Herb Enslen.

Distribution.—Dry pine barrens and sands, South Carolina to Central Florida and southeastern Texas.

Specimens examined.—LOUISIANA: *Carpenter s. n.* (Phila); ORLEANS PAR.: New Orleans, *Drummond s. n.* (Gray); POINTE COUPEE PAR.: Red River in dry sandy soil, *Hale s. n.* (Gray).

TEXAS: Reunion (probably Tarrant County), 1876, *Reverchon s. n.* (Field); AUSTIN CO.: sandy loam of prairie south of San Felipe, 5 May 1920, *Pennell* 10292 (Phila); BRAZOS CO.: near Creek, College Hills, 21 May 1940, *Reeves* 163A and 22 July 1940, 168A (Tracy); HARRIS CO.: low prairies, Houston, 18 April 1872, *Hall* 425 pp. (Field).

The plants from the eastern portion of the range tend to be rosulate and

with more narrowly spatulate leaves on the expanded portion than those in eastern Texas. One specimen (*Carpenter*) is much less hirsute than typical. The specimens from eastern Texas have somewhat larger flowers, often have broader leaves on the elongate stems, and have some of the characteristics of *R. humilis*. However, they seem at present best assigned to *R. ciliosa;* when *R. ciliosa* is better known throughout the western portion of its range they may better be segregated as a variety.

19. RUELLIA NOCTIFLORA (Nees) Gray, Syn. Fl. N. Am. 2: 326. 1878.

Ruellia tubiflora Le Conte, Ann. Lyc. N. Y. 1: 142: 1824.
Dipteracanthus noctiflorus Nees in DC., Prodr. 11: 123. 1847, in part.

Stems erect, simple or rarely branching either from the base or above, 1-5 dm. high, minutely and usually very sparsely cinerous-pilose or appressed puberulent, glabrescent, internodes elongated and often longer than the leaves; leaves broadly to narrowly lanceolate or elliptic oblong, thin, sparsely appressed puberulent or minutely hirtellous, tapering to a subacute or bluntly subacuminate apex, cuneate or broadly cuneate at base, sessile or subsessile, margin undulate, the larger 3-7 cm. long and .6-2.5 cm. broad; flowers short-peduncu-late, the two bracts linear to lanceolate, undulate; calyx segments linear, appressed-puberulent or minutely hirtellous, 2.5-4.5 cm. long; corolla light blue to white, expanding in the night, 6-10 cm. long, its tube about 5 cm. long, the slender throat only about 2 cm. long, limb 3.5-5 cm. broad; capsule puberulent, brownish, about 2 cm. long and .5 cm. broad.

Type.—"Inhabits in the savannahs of the Altamaka" collected by LeConte.

Distribution.—Savannas and wet pine barrens, evidently local, eastern Georgia to northwestern Florida, west to eastern Texas.

Specimens examined.—LOUISIANA: Bayou Lacombe, June 1880, *Langlois s. n.* (Field); CALCASIEU PAR.: near Lake Charles, 1904, *Allison s. n.* (US); ORLEANS PAR.: New Orleans, 1832, *Drummond* 258 pp. (Gray).

TEXAS: *Buckley s. n.* (Phila).

20. RUELLIA HUMILIS Nutt., Trans. Am. Phil. Soc. 5: 182. 1837, emend. Fern., Rhodora 47: 50. 1945.

Ruellia hirsuta Elliott, Sk. 2: 109. 1822, non Vellozo, Fl. Flum. 266. 1790.
R. ciliosa var. *longiflora* Gray, Syn. Fl. N. Am. 2: 326. 1878, in part.
R. ciliosa var. *humilis* (Nutt.) Britt., Trans. N. Y. Acad. Sci. 9: 185. 1890, in part.
R. humilis var. *typica Fernald, Rhodora* 47: 51. 1945.
Dipteracanthus noctiflorus var. *humilis* Nees in DC., Prodr. 11: 123. 1847, in part.

Coarse-stemmed perennial herb; stems 1-5 dm. tall, angled ,at first solitary and upright, often later divergently branched at the base or with more or less ascending or appressed branches above, growing from knotty shortened rhizomes, green or often purplish at the base, villous-hirsute with white hairs about 1 cm. long, often with puberulence and cystoliths; leaves of the main axis 3-18 pairs, 2-6 cm. long, 1-2.5 cm. broad, the main leaves lanceolate or rarely narrowly or broadly lanceolate, subsessile, obtuse to subacute, mostly hirsute to villous at least on the veins and margins, slightly reduced above;

bracts linear-lanceolate to elliptic, obtuse to subacute at apex, of similar texture to the leaves; flowers usually very few in the axils of the middle and upper leaves, subsessile; sepals linear, 1.5 cm. long at anthesis, often elongating to over 2 cm., green to purplish, hirsute to villous-cilite and with cystoliths; corolla lavender to pale blue, 3-4.5 cm. long, tube 1.2-2.5 cm. long, limb mostly 2 to rarely 3.5 cm. broad, or in the cleistogamous flowers the corolla reduced, tubular and closed; capsule about 1.2 cm. long, 3+ mm. broad, constricted at the base, brownish, glabrous; seed suborbicular, 3 mm. in diameter.

Type.—Arkansas, *Nuttall* in the New York Botanical Garden Herbarium (Torrey).

Distribution.—Dry prairies, rocky slopes, open woods, Minnesota to Texas, and locally to Pennsylvania, Virginia, and Alabama.

Specimens examined.—MINNESOTA: *Hitchcock s. n.* (KanSt..

IOWA: Coralville, 28 August 1907, *Somes s. n.* (Nebr); FREMONT CO.: prairie-steppe at top of loess ridge at Hamburg, 28 August 1917, *Shimek s. n.* (Iowa); JOHNSON CO.: prairie along railroad south of hills, 7 July 1906, *Shimek s. n.* (Iowa); prairie opening, Black Spring, 21 July 1911, *s. n.* (Texas) and 9 July 1915 *s. n.* (Iowa), sandy prairie along railroad west of river south of Iowa City, 17 August 1915 *s. n.* (Texas) and prairie along railroad east of Iowa City, 20-21 August 1915, *s. n.* (Iowa); LEE CO.: prairie banks along railway in timbered section east of Farmington, 30 August 1923, *Shimek s. n.* (Iowa) and Maryland Black Jack dune, Ft. Madison, 15 July 1938, *s. n.* (Texas).

ARKANSAS: rocky slopes and open ground, Eureka Springs, 22 September 1913, *Palmer* 4426 (US); CRAIGHEAD CO.: open woods, Lake City, 15 June 1927, *Demaree* 3391 (CalA); FAULKNER CO.: rocky glade, Guy, 4 September 1934, *Demaree* 10963 (US).

KANSAS.—BROWN CO.: 1925, *Horner s. n.* (KanSt); CHASE CO.: August 1895, *Hitchcock s. n.* (KanSt); COFFEE CO.: Burlington, July 1896, *Wimpey s. n.* (KanSt); COWLEY CO.: 22 August 1897, *Clothier and Whitford s. n.* (KanSt); GEARY CO.: smoky Hill township, herb along the railroad south of Junction City, 27 September, 1936, *Gates* 19786 (Nebr); JACKSON CO.: 28 July 1897, *Clothier and Whitford s. n.* (KanSt); JEFFERSON CO.: 20 July 1896, *Turner s. n.* (KanSt); LINCOLN CO.: July 1895, Hitchcock *s. n.* (KanSt); MARION CO.: August 1895, *Hitchcock s. n.* (KanSt); MORRIS CO.: August 1895, *Hitchcock s. n.* (KanSt); SALINE CO.: 27 July 1892, *Carleton s. n.* (KanSt).

OKLAHOMA: near Snake Creek, Indian Territory, 3 October 1896, *Ward* 13 (US); CARTER CO.: in Sand Canyon, a deep sandy canyon in the Cross Timbers with post-blackjack oak forest on the floor mingled with Andropogon and Bouteloua, six miles east of Ardmore, 31 October 1942, *Hopkins* 6362 (Okla); CLEVELAND CO.: prairie meadow 1 mile south of Noble, 26 June, *Berry* 17 (Okla); between Norman and Oklahoma City, 22 June 1928, *Martin* 38 (Pkla); CREEK CO.: common, Sapulpa, 22 June 1894, *Bush* 428 (MBG); LINCOLN CO.: Chandler, 29 June 1893, *Magenider s. n.* (MBG); LOGAN CO.: 6 miles north of Crescent along dry roadside, 11 June 1936, *Engleman* 112 (Okla); MCCURTAIN CO.: rather common in woods near Idabel, 18 May 1916, *Houghton* 3633 (Gray, MBG); OTTAWA CO.: in woods near Miami, 26 August 1913, *Stevens* 2304 (Gray); PAYNE CO.: loam soil one mile north of Stillwater, 19 May 1936, *Hindman* 101 (Texas); sandy clay soil four miles northeast of Stillwater, 11 July 1927, *Stratton* 141 (MBG).

TEXAS: *Buckley s. n.* (Phila); 1850, *Wright s. n.* (KanSt); BELL CO.: dry prairie north of Killeen, 14 August 1931, *Wolff* 3265 and between Moffat and Bland, 15 August 1933, 4306 (Tracy); BEXAR CO.: in low ground near Helotes Creek bank at Helotes, 12 August 1931, *Metz* 59 (CalA, NY); tropical life zone, Leon Springs, 7 June 1911,

Clemens 1057 (RMt); BOWIE CO.: T and T Junction, 27 August 1898, *Eggert s. n.* (MBG); BRAZOS CO.: College Hills Estates, College Station, 22 July 1940, *Reeves* 167 (US); CASS CO.: June 1926, *McClung s. n.* (Texas); DALLAS CO.: dry places, Dallas, July 1877, *Reverchon s. n.* (NY); one mile north of Cedar Hill, 28 August 1938, *Tharp* 46012 (Texas); DENTON CO.: postoak woods near Denton, 20 June 1933, *McBryde s. n.* (NTex); FAYETTE CO.: 1892, *Crawford* 7 and 9 (MBG) and 17 (Field); GILLESPIE CO.: Fredericksburg to Kerrville, 1 September 1930, *Whitehouse s. n.* (Texas); GRAYSON CO.: Denison, July 1933, *Peabody School* 48 (Texas); HARDIN CO.: Kountze, 20 April 1930, *Tharp s. n.* (Texas); HARRIS CO.: prairies, La Porte, 17 June 1903, *Reverchon* 3938 (MBG); damp prairies, Sheldon, 7 September 1903, *Reverchon s. n.* (MBG); HAYS CO.: sandy soil 400 yards up Onion Creek from road southwest of Dripping Springs, 27 July 1946, *Warnock and Krodel* 12 and 12-a (Texas); HILL CO.: 1940, *Mauldin* 46011 (Texas); KENDALL CO.: Spanish Pass, 11 August 1942, *Parks* Rx2010 (Tracy), Rx2014 (MBG), Rx2837 and Rx2839 (Tracy); KERR CO.: along Turtle Creek about 12 miles southwest of Kerrville, 29 August 1939, *Cory* 32524 (Gray); LAVACA CO.: Hallettsville, August 1912, *Fisher* 100 (US); LIBERTY CO.: twelve miles east of Cleveland, 2 June 1934, *Lehman s. n.* (Texas); MCLENNAN CO.: 14 June 1930, *Whitehouse s. n.* (Texas); MILAM CO.: sandy woods east of Milano, 1 August 1929, *Wolff* 1032 (Tracy); NEWTON CO.: Wiergate, 3 September 1923, *Tharp* 2674 (Texas); POLK CO.: 14 May 1942, *Tharp s. n.* (Texas); TRAVIS CO.: Austin, 1922-1923, *Painter* 76 (KanSt); not frequent, dry locations in open woods vicinity of Austin, 27 September 1942, *Taylor* 3042 (Calif); Austin, 20 July 1940, *Tharp s. n.* (Texas); gravelly soil, Austin, 1 August 1941, *s. n.* (Texas); TARRANT CO.: dry woods Fort Worth, 2 October 1910, *Ruth* 80 (Texas); SABINE CO.: 10 miles south of Yellow Pine, 3 October 1934, *Cory* 10798 (Gray); WOOD CO.: sand, Mineola, 18 October, *Reverchon s. n.* (MBG); VAN ZANDT CO.: Grand Saline swamps, 18 October, *Reverchon s. n.* (MBG).

Ruellia humilis is a widespread species showing a great deal of variation among its members. In the area of distribution under consideration, several rather distinctive variations can be distinguished, although many specimens are intermediate between the varieties.

20a. **Ruellia humilis** var. **depauperata** Tharp and Barkley, VAR. NOV.

Herbacea perennis; caule filiformi, glabrescenti vel sparse piloso; foliis sessilibus, membranaceis, spathulatis, oblanceolatis vel lanceolatis, puberulentis, sparse pubescentis vel sparse pilosis.

Slender perennial herb; stems 10-45 cm. tall, filiform to slender, erect from usually procumbent bases, usually growing in clusters from shortened rhizomes, subterete, green to purplish, finely puberulent and usually very sparsely pilose with white hairs about .5 mm. long, often appearing glabrate; leaves of the main axis 4-13 pairs, 1-4 cm. long, .5-1.5 cm. wide, the basal oblanceolate, lanceolate or narrowly lanceolate, subacute to subacuminate at apex, cuneate at base, and abruptly decurrent on the .5-1.5 mm. long petioles, repand-undulate, the middle pairs of leaves of the axis usually the largest, sparsely hirsute to puberulent above and on the veins beneath, pilose-ciliate on the margins; bracts lanceolate, acute, cuneate at the base, sessile, similar to the leaves in texture; flowers usually few on short peduncles in the axils of the middle and upper leaves; calyx segments linear, about 1.5 cm. long at anthesis, later elongating to over 2 cm., villous-hirsute and ciliolate, finely covered with small cystoliths; corolla lavender to light blue, 4.5 to mostly about 6 cm. long, limb 2.2 to mostly 3.5 cm. broad, tube 2.5 to mostly 3.5 cm. long; capsule 1.3± cm. long,

4± mm. broad, slightly constricted at base, brownish, glabrous; seeds several, suborbicular to ovate in outline.

Type.—Alluvial soil on South Spring Creek 25 miles north of Houston, Harris County, Texas, 9 August 1946, *Effie Boon* 500, in the Herbarium of the University of Texas.

Fig. 26.—*Ruellia humilis* Nutt. var. *depauperata* Tharp and Barkley. Type.

Distrib tion.—Louisiana, Oklahoma and Texas.

Specimens examined.—LOUISIANA: CALCASIEU PAR.: Lake Charles, 1887, *Ciosnuan* 9 (Nebr); low grassy soil one mile east of Lake Charles, 20 July 1938, *Correll and Correll* 9652 (Gray); JEFF DAVIS PAR.: knolls on low prairies, Welsh, 17 May 1915, *Palmer* 7649 (CalA).

OKLAHOMA.—CLEVELAND CO.: east of Norman, Prairie, 26 September 1926, *Little* 368 (Okla).

TEXAS: east Texas, 2 July 1923, *Tharp* 2665 (Texas, US); AUSTIN CO.: sandy loam of Prairie, San Felipe, 5 May 1920, *Pennell* 10292 (NY); BRAZORIA CO.: Angleton, 14 August 1933, *Tharp s. n.* (Texas); Alvin, 22 April 1918, *Young s. n.* (Texas); BRAZOS CO.: alluvial woods, College Station, 22 July 1940, *Reeves* 168 (US); CHAMBERS CO.: Anahuac, 21 July 1929, *Tharp s. n.* (Texas); FORT BEND CO.: Richmond, 20 April 1899, *Bray* 96 (Texas, US); GALVESTON CO.: 10 May 1942, *Nelson s. n.* (Gray, Texas); Galveston to Houston Highway, 31 August 1937, *Schulz* 3794 (Field); HARDIN CO.: 2.6 miles east of Camp Jackson, 13 September 1936, *Cory* 19793, 5 miles southeast of Village Mills, 13 May 1937, 22144 (Gray); in pine land near Ariola, 18 August 1942, *Lundell and Lundell* 11494 (SMU); Humble, 11 September 1926, *Tharp* 4531 and 10 September 1937, *s. n.* (Texas); HARRIS CO.: clay soil of old pasture, Houston, 20 May 1903, *Bebb* 1205 (Okla, Texas); two miles north of Seabrook, 29 August, *Boon* 210, 2 miles east of Hockley, 14 July 1946, 307 and 308, 3 miles south of Hockley, 12 July 1946, 309 and 310, 1 mile west from the mouth of Sims Bayou, 13 July 1946, 311, alluvial soil on South Spring Creek 25 miles north of Houston, 9 August 1946, 500, and 5 miles south of Hockley, 10 August 1946, 419, 420 and 421 (Texas); low prairies, Houston, 18 April 1872, *Hall* 425 (NY, US) and 1872, 625 (MBG); Whiteoak Bayou, 1840, *Lindheimer* 96 (MBG); prairie, La Porte, 17 June 1903, *Reverchon* 3938 (MBG, NY); April 1930, *Tharp s. n.* (Texas); JEFFERSON CO.: Beaumont, 10 September 1937, *Tharp s. n.* (Texas); MATAGORDA CO.: citrus grove, 1930, *Johnson s. n.* (Texas); MONTGOMERY CO.: Willis, 20-25 June 1908, *Dixon* 271 (Field); TARRANT CO.: Fort Worth, 9 September 1877, *Ward s. n.* (US); TOM GREEN CO.: Knickerbocker Ranch, Dove Creek, May 1880, *Tweedy* 1 (US); TYLER CO.: in pine land south of Woodville, 19 August 1942, *Lundell and Lundell* 11544 (SMU, US); WALKER CO.: vicinity of Huntsville, 9-12 July 1909, *Dixon* 377 (Field, Gray, NY); WHARTON CO.: Wharton, 2 September 1937, *Tharp s. n.* (Texas).

20b. RUELLIA HUMILIS Nutt. var. FRONDOSA Fernald, Rhodora 47: 54. 1945.

R. ciliosa auths. non Pursh, Fl. Am. Sept. 2: 420. 1814.

R. humilis Nutt., Trans. Am. Phil. Soc. 5: 182. 1837, in part.

Coarse perennial herb; stems usually erect 20-40 cm. tall, branched with coarse, often divergent branches, growing from knotty shortened rhizomes, purplish to bright green, strongly villous-hirsute with white hairs about 2 mm. long, with or without small cystoliths; leaves of the main axis 3-10 pairs, 2-8 cm. long, 1-4 cm. broad, the main leaves ovate, suborbicular, or mostly oval-oblong or broadly elliptical, subacute or mostly obtuse or rounded, margin subentire or undulate, truncate to broadly cuneate at the base, decurrent on the 1-2 mm. long petiole, sparsely hirsute on the upper surface and on the veins below, ciliate with long white hairs; bracts lanceolate or usually elliptical usually acute at apex, cuneate at base, similar to the leaves in texture; flowers usually very few in the axils of the middle and upper leaves, subsessile; sepals linear, about 1.5 cm. long at anthesis, sometimes elongating to 2 cm., sparsely villous-hirsute and conspicuously ciliolate; corolla lavender to light blue, 3 to

rarely 4.5 cm. long, tube about 2 cm. long, limb 2-3 cm. broad; capsule about 1.2 cm. long, 4-5 mm. broad, constricted at the base, brownish, glabrous, seed few, suborbicular in outline.

Type.—Marion County, Indiana, abundant among tall weeds between Indianapolis and Carmel, 8 August 1942, *R. C. Friesner* 17202 in Gray Herbarium of Harvard University.

Distribution.—South central Pennsylvania and western Virginia to Iowa, Nebraska, Louisiana and Texas.

Specimens examined.—IOWA: IOWA CO.: alluvial prairie south of Amana, 22 July 1915, *Shimek s. n.* (Iowa); LOUISA CO.: sandy border of Dewey's swamp southwest of cone, 17 July 1927, *Shimek s. n.* (Iowa); MUSCATINE CO.: alluvial prairie southeast of Salisbury bridge, 28 June 1923, *Shimek s. n.* (Iowa), alluvial prairie, 28 June 1923, *s. n.* (Texas), alluvial prairie southeast of Salisbury bridge, 21 August 1927, *s. n.* (Iowa).

ARKANSAS: June 1886, *Hasse* 6467 (CalA).

LOUISIANA: RAPIDES PAR.: infrequent, pine woods, near Alexandria, 6 June 1899, *Ball* 655 (US).

NEBRASKA: OTOE CO.: Nebraska City, July 1900, *Thornber s. n.* (Ariz, Texas).

KANSAS: CLAY CO.: July 1895, *Hitchcock s. n.* (KanSt).

OKLAHOMA: *Flowers* 56 (Okla); HARMON CO.: 5 miles east of Harmon, 17 June 1932, *Wilkens* 2482 (Phila); LINCOLN CO.: Chandler, 29 June 1893, *Magenider s. n.* (MBG); OKLAHOMA CO.: Oklahoma City, July 1892, *Shimek s. n.* (Iowa); STEPHENS CO.: Marlow, 23 August 1894, *Eggleston s. n.* (KanSt).

TEXAS.—BELL CO.: dry woods near Temple, 14 June 1930, *Wolff* 2288 (US); BRAZOS CO.: College Hills, College Station, 22 July 1940, *Reeves* 167A (Tracy); TRAVIS CO.: Austin, *Wright s. n.* (Gray); VAN ZANDT CO.: sandy pasture, 1 mile east of Martin's Mills, 7 May 1939, *Timmons* 522 (NY); WOOD CO.: postoak woods, 5 July 1924, *Tharp* 2939 (Texas, US).

In general the specimens at the western limits of the range tend to have narrower leaves which are often more subacute than those from the type locality.

20c. RUELLIA HUMILIS Nutt. var. LONGIFLORA (Gray) Fernald, Rhodora 47: 56. 1945.

R. ciliosa var. *longiflora* Gray, Syn. Fl. N. Am. 2: 326. 1878.
Dipteracanchus Drummondii Torr. and Gray ex Engelm. and Gray, Bost. Jour. Nat. Hist. 5: 258. 1845, non *D. Drummondianus* Nees, in DC., Prodr. 11: 197. 1847.

Coarse perennial herb; stems 10-50 cm. tall, erect or rarely decumbent at the base, usually with a few slender appressed branches, usually growing from a knotty shortened rhizome, strongly four-angled to rarely subterete, usually bright green, usually conspicuously villous-hirsute with white hairs about 2 mm. long, finely and coarsely covered by small cystoliths and appressed-puberulent in the axils of the leaves, or rarely glabrate; leaves of the main axis usually 5-10 pairs, 2.5-5.5 cm. long, lanceolate, subacute to acute, cuneate to subcuneate at the base and decurrent on the very short petiole, undulate margined, the leaves above often smaller and narrower, hirsute above and below and covered with small cystoliths, margin ciliolate with long white hairs; bracts lanceolate, similar to the leaves in texture; flowers usually few in the axils of the median and upper leaves on very short peduncles; calyx lobes

linear, about .5 mm. broad at the base and 1.5+ cm. long at anthesis, elongating later to about 2.5 cm., sparsely hirsute and conspicuously hirsute-ciliate on the margins; corolla lavender to light blue, 4.5-7 cm. long, tube 3-4.5 cm. long, limb 2.5-3.5 cm. in diameter; capsule 1.3-1.5 cm. long, 3-4 mm. broad, constricted at the base, brownish, glabrous; seed few, suborbicular to ovate in outline.

Type.—Western Louisiana, *Hale,* in the New York Botanical Garden (Torrey) Herbarium.

Distribution.—Illinois and Iowa to Louisiana and Texas.

Specimens examined.—IOWA: APPANOOSE CO.: upland prairie opening northwest of Unionville, 15 August 1919, *Shimek s. n.* (Iowa); JOHNSON CO.: Iowa City, 15 July 1883, *Shimek s. n.* (Nebr), prairie opening, Black's Spring, 23 and 29 June 1910, *s. n.* (Texas) and sandy prairie south of aviation field, Iowa City, 14 July 1923, *s. n.* (Texas); LEE CO.: sand terrace southwest of Fort Madison, 31 August 1923, *Shimek s. n.* (Iowa); LINN CO.: Cedar Rapids, 15 July 1913, *Berry s. n.* (Iowa); open sandy alluvial flat, Cedar Rapids, July 1898, *Shimek s. n.* (Iowa); LOUISA CO.: top and west slope of Big Sand Mound near north line of the county, 11 September 1911, *Shimek s. n.* (Iowa); LUCAS CO.: upland prairie east of Lucas, 17 October 1931, *Shimek* (Iowa); MADISON CO.: prairie opening on Backbone southwest of Winterset, 21 August 1917, and 13 August 1919, *Shimek s. n.* (Iowa); MUSCATINE CO.: dry soil, August 1895, *Reppert s. n.* (Iowa); sand at Adams, 21 August 1915, *Shimek s. n.* (Texas); RINGGOLD CO.: prairie 1 mile west of Tingley, 16 October 1931, *Shimek s. n.* (Iowa); VAN BUREN CO.: prairie along railroad west of Farmington, 4 August 1923, *Shimek s. n.* (Iowa).

MISSOURI: common in rocky ground, Independence, 10 June 1894, *Bush s. n.* (KanSt); JEFFERSON CO.: Pacific, May 1909, *Craig s. n.* (Ariz); MARION CO.: near Mark Francis Cave in dry fields, 24 September 1909, *Davis s. n.* (Texas); Mount Olivet Cemetery, Hannibal, 1 July 1913, *Davis s. n.* (Nebr) and Mount Olivet Cemetery, 21 July 1915, *Davis s. n.* (KanSt).

ARKANSAS: northwestern Arkansas, September, *Harvey s. n.* (KanSt); CRAWFORD CO.: Fort Smith, 1853-1854, *Bigelow s. n.* (US); FAYETTE CO.: Colony, June 1892, *Crawford s. n.* (KanSt); LOGAN CO.: dry rocky situations, Magazine Mountain, elev. 2800 ft., 18 June 1938, *Demaree* 17720 (Okla).

LOUISIANA.—CALCASIEU PAR.: Lake Charles, 7 August 1897, *Tracy s. n.* (US); NATCHITOCHES PAR.: Chopin, 6 May 1915, *Palmer* 7565 (CalA).

NEBRASKA.—LANCASTER CO.: roadside near Pioneers Park, Lincoln, September 1931, *Sperry s. n.* (Nebr); prairies at Lincoln, 2 July 1893, *Turrell s. n.* (Ariz); OTOE CO.: Nebraska City, September 1900, *Thornber s. n.* (Ariz) and Nebraska City, 15 July 1905, *s. n.* (Ariz, Texas).

KANSAS: between Neosha and Redfork, June to September 1849, *Marcy's Expedition s. n.* (Gray); ATCHISON CO.: October 1896, *Hitchcock s. n.* (KanSt); BOURBON CO.: Fort Scott, 15 July 1887, *Kellerman s. n.* (KanSt); BUTLER CO.: White Water, August 1892, *Hitchcock s. n.* (KanSt); CHAUTAUQUA CO.: 8 August 1896, *Hitchcock s. n.* (KanSt); CHEROKEE CO.: 14 August 1897, *Clothier and Whitford s. n.* (KanSt); prairie south of Monmouth, 2 July 1929, *Jacobs* 91 (KanSt); CRAWFORD CO.: Cherokee, 14 July 1887, *Kellerman s. n.* (KanSt); CLOUD CO.: 1930, *Fraser* 403 (KanSt); DICKINSON CO.: June 1896, *Hitchcock s. n.* (KanSt); DOUGLAS CO.: 6 July 1896, *Brown s. n.* (KanSt); ELK CO.: 20-21 August 1897, *Clothier and Whitford s. n.* (KanSt); FRANKLIN CO.: July 1896, *Hitchcock s. n.* (KanSt); GEARY CO.: 31 July 1895, *Norton s. n.* (KanSt); GREENWOOD CO.: Eureka, July 1892, *Hitchcock s. n.* (KanSt); HARVEY CO.: 27 August 1897, *Clothier and Whitford s. n.* (KanSt); JOHNSON CO.: Olathe, 7 July 1887, *Kellerman s. n.* (KanSt); 1890, *Pellet s. n.* (KanSt); KINGMAN CO.: 23

August 1896, *Hitchcock s. n.* (KanSt); LABETTE Co.: 18 August 1897, *Clothier and Whitford s. n.* (KanSt); LEAVENWORTH Co.: 3 August 1897, *Clothier and Whitford s. n.* (KanSt); MARSHALL Co.: July 1895, *Sanderson s. n.* (KanSt); Irving, 5 July 1890, *Thompson s. n.* (KanSt); MIAMI Co.: Paola, September 1892, *Hitchcock s. n.* (KanSt); MONTGOMERY Co.: August 1896, *Hitchcock s. n.* (KanSt); Golf links 5 miles northeast of Caney, 29 June 1929, *Rydberg and Imler* 401 (Nebr) and 415 (KanSt); OSAGE Co.: Osage City, 28 July 1887, *Kellerman s. n.* (KanSt); OTTAWA Co.: July 1895, *Hitchcock s. n.* (KanSt); SALINE Co.: comomn on prairies near Brookville, 2 July 1930, *Hancin* 450 (KanSt); SHAWNEE Co.: open prairie north of Auburn, 7 July 1927, *Maus* 865 (KanSt); SUMNER Co.: Wellington, July 1892, *Hitchcock s. n.* (KanSt); WABAUNSEE Co.: dry roadside northeast of Keene, 16 June 1926, *Maus s. n.* (KanSt); Vera, 4 July 1894, *Norton s. n.* (KanSt); WASHINGTON Co.: 24 July 1897, *Clothier and Whitford s. n.* (KanSt); WOODSON Co.: 29 August 1897, *Clothier and Whitford s. n.* (KanSt).

OKLAHOMA: in field beside Salt Creek east of Finley, 20 June 1919, *Jeffs s. n.* (Okla); North Fork of the Canadian, September to October 1850, *Marcy's Expedition s. n.* (Gray); CIMARRON Co.: near Cimarron City, July 1893, *Olive* 89 (Field); CLEVELAND Co.: low land east of Norman, 10 June 1928, *Barkley* 493 (Okla); dry open prairies composed of Garber Sandstone 3 miles south of Norman, 18 July 1941, *Clark* 37 (Calif); dry to open plains in "Blackjacks," July 1917, *Cliifton s. n.* (Okla); four miles east of Norman, 13 June 1936, *Eskew* 1044 (Okla); dry sandy soil in pasture near Norman, 29 June 1922, *Jeffs s. n.* (Okla); in grassy area 3.5 miles east of Norman, 11 June 1936, *Hoisington* 17 (Okla); dry clay three miles southeast of Norman, 14 June 1939, *Neill* 57 (Okla); moist soil on Canadian River bank, 23 June, *Personett* 77 (Okla); COMANCHE Co.: base of Mount Scott, Wichita Mountains Wildlife Refuge in clay soil, 23 September 1941, *McMurry* 1080 (Okla); mixed grass association on mesa south of Meers in Wichita National Forest, 4 July 1941, *Waterfall* 2917 (Okla); CRAIG Co.: along roadside ten miles north of Vinita, 19 June 1938, *Goodman* 3047 (Gray); ELLIS Co.: Arnett, sand, 25 August 1927, *Locks* 35 (US); HASKELL Co.: open prairie by roadside 5 miles south of Kinta, 6 September 1940, *Hopkins and Bemm* 5142 (Okla); KAY Co.: Tonkawa, in plowed ground, 26 September 1908, *Barker* 30 (Field); KINGFISHER Co.: east of Cashion, 26 June 1935, *Grace* 225 (Okla); LATIMER Co.: Wilburton, 12 June 1930, *Clark* 11080; LOGAN Co.: dry roadside six miles north of Crescent, 11 June 1936, *Engleman* 111 (Okla); prairie, 24 June 1938, *Smith* 554 (Okla); MAYES Co.: Camp Scott near Locust Grove, 20 July 1940, *Flowers* 423 (Okla); MCCLAIN Co.: not common on prairie seven miles west of Norman in Johnson's pasture, 25 June 1937, *Eskew* 1968 (Okla); MCCURTAIN Co.: cut-over pine-oak in year old fire burn, 8 June 1930, *Little and Olmsted* 218 (Okla); MUSKOGEE Co.: three miles east of Fort Gibson, 2 June 1939, *Bebb* 4227 (Okla); abundant on dry prairie soil, summer 1925, *Little* 564 and 31 July 1927, 1952 and 1953 (Okla); MURRAY Co.: exposed and open slope, Sylvan Shale, near Scott's Dome, Arbuckle Mountains, 13 July 1940, *Becker, Kennedy and Waterfall* 5339 (Okla); sheltered pasture, Sulphur Township, 21 June 1939, *Broadbent* 55 (Okla); dry open pasture in undifferentiated limestones of Pennsylvanian Age two and a half miles south of Sulphur in the Arbuckle Mountains, 28 June 1941, *Hopkins* 6077 (Okla); Sulphur, in dry soil, 29 July 1937, *Morgan s. n.* (Okla); OKLAHOMA Co.: open ground, Edmond, 26 June 1931, *Smith s. n.* (Okla); red sand nine miles northwest of Oklahoma City, 11 June 1939, *Wall* 30 (Okla); Lincoln Park, Oklahoma City, 12 June 1939, *Warner* 49 (Okla); sandy soil in open woods west of Lake Kiwassee, 2 June 1939, *Waterfall* 1320, clay and sandstone hillside four miles north and five miles west of Edmond, 28 June 1940, 2212 and clay soil in hayfield, .5 miles south and 2 miles west of Marion, 12 July 1941, 2982 (Okla); OTTAWA Co.: three miles south of Miami, *Whaley* 97 (Okla); PAYNE Co.: sandy loam soil along roadside two miles north of Stillwater, 19 July 1941, *Henson* 302 (Okla); clay loam, Stillwater, 23 July 1939, *Lenhart* 83 (Calif); clay soil, Stillwater, 26 June 1937, *Mader* 50 (Okla); Yale, 22 July 1905, *Van Vleet s. n.* (Okla, US); Stillwater, 9 June 1893, *Waugh* 144 (KanSt, MBG, US); PITTSBURG Co.: six miles east of Hartshorn in black-jack forest, 20 June 1928, *Barkley* 491 (Okla); POTTAWATOMIE Co.: roadside south of Tecumseh, 6 June 1932, *Barkley*

218 (Okla); clay bank of creek, St. Louis, 16 May 1936, *Faulkner* 122 (Okla); dry prairie, Avaca Township, 30 August 1938, Jacobs 42 (Okla); ROGER MILLS CO.: in shinnery, 8 July 1939, *Engleman* 3058 (Okla); SEMINOLE CO.: sandy open field at Seminole, 21 June 1936, *Osborne and Kusecker* 54 (Okla); TULSA CO.: roadsides and prairies, 13 July 1928, *Force s. n.* (Okla).

TEXAS: *Drummond* 220 (Gray, NY) and 219 and 258 (Gray); 1842, *Lindheimer* 142 (MBG) and 1843, 158 (Gray, MBG, Phila); *Reverchon* 725 and dry rocks, 25 July 1902, *s. n.* (MBG); borders of thickets on the Blanco, July, *Wright s. n.* (KanSt), and *s. n.* (Gray); ANDERSON CO.: Elkhart, 7 July 1935, *LeSueur and Smith s. n.* (Texas); BASTROP CO.: McDade, 14 August 1936, *Collins s. n.* (CalA, Calif, Gray, MBG, Texas); BEXAR CO.: hills, 7 September 1900, *Eggert s. n.* (MBG); BRAZOS CO.: woods in College Hill Estates at College Station, 21 May 1940, *Reeves* 163 (US); CAMP CO.: Pittsburg, 13 September 1923, *Tharp* 2683 (Texas) COLLIN CO.: 3 miles south of McKinney, 3 June 1939, *Timmons* 647 (NTex); COMAL CO.: 1850-1851, *Lindheimer and Dapprich* 8239 (SMU); COMANCHE CO.: De Leon, 12 June 1941, *Tharp s. n.* (Calif); DALLAS CO.: dry ground north of Dallas, 25 June 1899, *Eggert s. n.* (MBG); in White Rock Creek bottom north of Lake, 26 August 1942, *Lundell and Lundell* 11676 (SMU, US) and off old Seagoville Road north of Seagoville, 27 August 1942, 11679 (SMU); June 1874, *Reverchon* 410 (Gray) and dry upland, Dallas, 725 (MBG); vicinity of Dallas, 6 June 1929, *Stephenson* 92 (US); DE WITT CO.: western part of county, 30 July 1941, *Riedel s. n.* (Gray, MBG, Texas); ERATH CO.: 16 May 1921, *Gough s. n.* (Texas), dry rocky banks, Stephenville, 21 June 1918, *Palmer* 14185 (MBG, US); FAYETTE CO.: Colony, June 1892, *Crawforch s. n.* (Nebr); GILLESPIE CO.: *Jermy s. n.* pp. (MBG); Fredericksburg, 31 July 1936, *Grote* 19119 (Gray); GREGG CO.: July 1939, *York s. n.* (MBG); HARRIS CO.: low ground, Houston, 28 May 1903, *Biltmore Herbarium* 4501b (US); eight miles west of Humble, *Boon* 88 (Texas); in woods, Houston, June 1842, *Engelmann s. n.* (MBG); HAYS CO.: San Marcos and vicinity, summer 1899, *Stanfield s. n.* (NY); HOUSTON CO.: Lovelady, 17 April 1930, Freeman s. n. (Texas); in sandy open ground, Latexo, 22 September 1917, *Palmer* 12820 (Calif, MBG, RMt, US); JEFFERSON CO.: 11 miles west of Beaumont, 11 April 1921, *Wherry s. n.* (US); JOHNSON CO.: Cleburne, 15 June 1930, *Whitehouse s. n.* (Texas); LAVACA CO.: Hallettsville, 18 June 1923, *Tharp* 2662 (Texas, US); LEE CO.: 17 January 1931, *Knobloch s. n.* (Texas); Elgin to Brenham, 15 July 1929, *Whitehouse s. n.* (Texas); LIBERTY CO.: 12 miles east of Cleveland, 2 June 1934, *Lehman s. n.* (Texas); MCLENNAN CO.: Waco, 21 July 1929, *Whitehouse s. n.* (Texas); MONTGOMERY CO.: transition of black soil to sand, Willis, May, *Warner s. n.* (MBG); PARKER CO.: *Man s. n.* (MBG); RUSK CO.: sandy woods, *Vinzent* 85 (Paris); RED RIVER CO.: Bogata, 18 June 1947, *Tharp* 47328 (Texas); SMITH CO.: in light leafmold over red sandstone clay, open oak woodland, Amigo, 4 August 1945, *Moore* 991 (Gray); TARRANT CO.: in brush lands, Fort Worth, 8 May 1905, *Bebb* 2494 (Okla); 1926, *Killian* 6887 (Texas, US); sandy post-oak woods between Grapevine and Fort Worth, 17 June 1940, *Lundell and Lundell* 9516 (US); open woods, 2 October 1912, *Ruth* 103 (Gray), dry woods, 10 August 1912, 103 (MBG, NY), dry woods near Fort Worth, 27 June 1911, 103 (NY), common on dry ground, 9 May 1929, 103 (SMU) and rich soil, Fort Worth, 18 September 1909, 105 (US); TRAVIS CO.: growing in chalky Cretaceous limestone in hot open area near edge of cliff 5 miles south of Austin, 9 August 1946, *Barkley* 16T497 (Texas); Austin, 17 August 1922, *Tharp* 1384 (Texas, US), Austin, 30 September 1925, 3744 (Texas) and 20 July 1940, *s. n.* (Calif, SMU); scattered along highway in limestone soil about 11 miles west of Austin, 26 June 1946, *Warnock* 46461 (Texas); TYLER CO.: 20 June 1947, *Tharp* 47329 (Texas); VAN ZANDT CO.: in woods near Hollis Springs Cemetery, 4 July 1939, *Bass* 30 (NTex); WALKER CO.: Huntsville, 3-12 June 1908, *Dixon* 111 and Riverside, 19 June 1908, 218 (Field); Huntsville, 4 April 1936, *Warner s. n.* (Texas); WASHINGTON CO.: 20 June 1938, (Texas); WHARTON CO.: August 1937, *Tharp* 44404 (Texas); WISE CO.: Decatur, 18 June 1947, *Tharp* 47327 (Texas); WOOD CO.: woods near Golden, 15 August 1926, *McMullen s. n.* (Texas).

This variety shows very close relationship to the typical variety with the

corolla length of a few specimens intermediate; it shows a transition from the broader leaves of var. *expansa* to the very narrow leaves of var. *depauperata*. Plants from Oklahoma, Louisiana and Nebraska are very compact in stature. Intermediate characteristics toward var. *depauperata* are illustrated by many specimens (for example from Texas *Tharp* 27 July 1940, *Ruth* 103, Whitehouse 15 July 1929, *Moore* 991, and *Collins* 14 August 1936, from Nebraska by *Thornber* 15 Sept. 1900, from Oklahoma by *Broadbent* 55, *Clark* 37 and *Locke* 35, and from Kansas by *Kellerman* 14 July 1887). Some specimens show close affinity to *R. ciliosa* (for example from Louisiana, *Palmer* 9565, from Kansas Marcy's Expedition and from Texas *Warner* 4 April 1936).

20d. RUELLIA HUMILIS Nutt. var. EXPANSA Fernald, Rhodora 47: 58. 1945.

Ruellia ciliosa auths. in part non Pursh, Fl. Am. Sept. 2: 420. 1814.
R. humilis Nutt., Trans. Am. Phil. Soc. 5: 182. 1837, in part.

Coarse perennial herb; stems usually erect, 10-80 cm. tall, usually branched with slender to coarse, usually erect branches, usually growing in clusters from knotty shortened rhizomes, four-angled except terete toward the base, bright green (to rarely purplish), villous-hirsute with scattered white hairs about 1.5 mm. long, finely covered by small cystoliths and with appressed puberulence in lines above the leaf axils; leaves of the main axis 4-14 pairs, 4-7 cm. long and 2-4.5 cm. broad, the basal broadly ovate, broadly oval, or ovate-oblong, obtuse or rarely subacute, rounded to very broadly cuneate and decurrent on the 1-3 mm. long petiole, undulate margined, the basal pair small, increasing in size until a maximum size is reached in the third or fourth pair and then gradually reduced above, the upper leaves often narrowly ovate or lanceolate, usually subacute or acute, glabrate or sparsely hirsute with long hairs, margin ciliate with white hairs 1-1.5 mm. long; bracts usually lanceolate or less often oblong, oblanceolate or elliptic, similar to the leaves in texture; flowers usually few in the axils of the middle and upper leaves, sessile, or on very short peduncles; calyx-lobes linear, about .5 mm. broad at base and about 1.5 cm. long at anthesis, elongating later to about 2.3 cm., villous-hirsute and ciliolate; corolla lavender to very light blue, 6± cm. long, tube 3± cm. long, limb 2.5-4.0 cm broad, an occasional flower reduced and about 3 cm. long or rarely much reduced, closed, tubular, cleistogamous; capsule 1 cm. long, 2+ mm. broad, constricted at base, brownish, glabrous; seed few, suborbicular to ovate in outline.

Type.—Macon County, Illinois, in openings in timber, 1 July 1915, *I. W. Clokey* 2429 in the Gray Herbarium at Harvard University.

Distribution.—Michigan, Indiana, Mississippi and Florida west to Iowa, Kansas and Texas.

Specimens examined.—IOWA: APPANOOSE CO.: upland prairie opening west of Unionville, 13 August 1923, *Shimek s. n.* (Iowa); DECATUR CO.: prairie, Morgan Township in southwest part of county, 12 June 1902, *Shimek s. n.* (Iowa); DES MOINES CO.: Skunk River valley, 1 August 1895, *Bartsch s. n.* (Iowa); opening in woods northeast of Augusta, 14 July 1928, *Shimek s. n.* (Iowa); FREMONT CO.: Hamburg, 26 June 1890, *Shimek s. n.* and Hamburg, 31 August 1898 *s. n.* (Iowa); JOHNSON CO.: sandy prairie along railroad south of Aviation Field, Iowa City, 3 July 1917, *Shimek s. n.* (Iowa);

LEE CO.: Keokuk, 5 July 1895, *Shimek s. n.* (Iowa); LOUISA CO.: sandy alluvial plain west of Big Sand Mound, 26 June 1909, *Shimek s. n.* (Iowa); Muscatine Island, August 1897, *Shimek and Myers s. n.* (Iowa); MAHASKA CO.: prairie in cemetery north of campus of Penn College at Oskaloosa, 12 July 1921, *Shimek s. n.* (Iowa); MUSCATINE CO.: frequent in dry soil, July 1890, *Reppert* 343 (Iowa); sandy alluvial area east of Adams, 16 July 1910, *Shimek s. n.*, sandy roadside on alluvial flat south of Muscatine, 12 June 1911, *s. n.*, sand at Adams, 29 September 1911, *s.n.* and sandy slopes northwest of Bayfield, 28 June 1913, *s. n.* (Iowa), sandy area at Adams, 3 July 1915, *s. n.* (Texas), sandy prairie along railway from Wilton to Moscow, 28 June 1917, *s. n.* (Iowa, Texas), sandy alluvial flat near north end of Big Sand Mound, 19 July 1922, *s. n.* and low prairie (drained swamp) on flat along railroad 1 mile west of Nichols, 28 June 1923, *s. n.* (Iowa), sandy alluvial prairie southeast of Salisbury bridge, 2 September 1924, *s. n.* and sandy flat at Salisbury Bridge, 22 August 1926, *s. n.* (Texas), opening on wooded dune east of pond 8 miles northwest of Muscatine, 10 July 1928, *s. n.* (Iowa), old prairie sand dune at schoolhouse 7 miles northwest of Muscatine, 11 July 1928, *s. n.* (Iowa, Texas); UNION CO.: oak barrens on ridge southwest of Ofton Junction, 27 July 1923, *Shimek s. n.* (Iowa); VAN BUREN CO.: prairie openings at Pittsburg, 14 June 1902, *Shimek s. n.* and open place along road north of Koesaugua, 3 July 1930, *s. n.* (Iowa); WAPELLO CO.: open places in upland woods near Cliffland, 14 June 1902, *Shimek s. n.* (Iowa).

MISSOURI: common in fields, Eagle Rock, 29 June 1897, *Bush* 506 (KanSt); JACKSON CO.: common in dry grounds, Kansas City, 4 July 1896, *Mackenzie s. n.* (KanSt); LAFAYETTE CO.: 1 mile west of Concordia in hard baked clay, 14 September 1946, *Trusik, Busch and Walle* 21 (Texas).

ARKANSAS.—POPE CO.: Grand Prairie, prairies De Valls Bluff, elev. 190 ft., *Demaree* 22186 (Calif); PRAIRIE CO.: Grand Prairie near Hazen, elev. 240 ft., 29 June 1941, *Demaree* 23304 (CalA, Calif, Okla).

LOUISIANA: *Steinhauer s. n.* (Phila); NATCHITOCHES PAR.: dry open ground, Natchitoches, 10 June 1915, *Palmer* 7940 (CalA, US); RAPIDES PAR.: Alexandria, *Hale s. n.* (Phila); Alexandria, 1844, *Mohr s. n.* (US); RED RIVER PAR.: *Hale* (?) *s. n.* (Gray).

KANSAS.—ANDERSON CO.: in dry soil southeast of Welda, 1 September 1927, *Maus* 621 (KanSt); BROWN CO.: 29 July 1897, *Clothier and Whitford s. n.* (KanSt); BUTLER CO.: herb along roads, August 1926, *Johnson s. n.* (KanSt); CRAWFORD CO.: 6 miles southeast of Pittsburg, 21 June 1929, *Rydberg and Imler* 164 (KanSt); ELLSWORTH CO.: July 1895, *Hitchcock s. n.* (KanSt); LINN CO.: Mound City, 18 July 1887, *Kellerman s. n.* (KanSt); MCPHERSON CO.: Roxburg, 21 June 1887, *Babcock s. n.* (KanSt); NEOSHO CO.: Thayer, 1891, *Ewing s. n.* (KanSt); POTTAWATOMIE CO.: pasture, 26 June 1931, *Wahl* 60 (KanSt); RILEY CO.: near Randolph, 17 June 1886, *Cleburne s. n.* (Nebr.); herb on pine hillsides near Manhattan, 22 September 1923, *Gates* 13869 (KanSt); Manhattan, October 1898, *Hitchcock s. n.* (KanSt); Manhattan, 10 June 1887, *Kellerman s. n.* and 15 June 1887, *s. n.* (KanSt); prairie, 15 June 1895, *Norton* 386 (KanSt, NM); SEDGWICK CO.: Wichita, March 1892, *Miller s. n.* (KanSt); SHAWNEE CO.: Topeka, 2 July 1879, *Popenoe s. n.* (KanSt); WILSON CO.: Roper, 4 June 1896, *Hitchcock s. n.* (KanSt).

OKLAHOMA: Fonts, 26 June 1895, *Blankenship s. n.* (Gray); *Flowers* 56 (Okla); 18 May 1936, *Hindman s. n.* (Texas); BRYAN CO.: Colbert's Station, 15 June 1891, *Sheldon* 14 (US); CADDO CO.: chiefly on the False Washita between Fort Cobb and Fort Arbuckle, 1868, *Palmer* 231 (US); CLEVELAND CO.: pasture near Noble in rich soil, 1922, *Bayliff s. n.* (Okla); in overflow land, 28 May 1939, *Bebb* 4079 (Okla); Norman, 25 August 1914, *Emig* 522 (MBG); COMANCHE CO.: Fort Sill, 29 May 1916, *Clemens* 11782 (CalA, Gray, MBG); Medicine Park in the Wichita Mountain, in creek, 19 June 1936, *Demaree* 13027 (Okla); JOHNSTON CO.: Milburn, 19 June 1929, *Tharp s. n.* (Texas); HASKELL CO.: 30 May 1940, *Bebb* 5364 (Okla); LOGAN CO.: west of

Guthrie, 2 July 1933, *Grace* 48 (Okla); McINTOSH Co.: prairies along railroad, 3 June 1939, *Bebb* 4275 (Okla); MUSKOGEE Co.: 14 June 1927, *Little* 702 and 703 (Okla); OKLAHOMA Co.: sand in pasture .5 miles east of Nicoma Park, 7 June 1940, *Waterfall* 2069 (Okla); OSAGE Co.: on dry knoll, 7 August 1913, *Stevens* 1931 (Gray, MBG, Okla, US); PAYNE Co.: sandy loam soil at Stillwater, 9 June 1937, *Friend* 9 (CalA); two miles southeast of Stillwater, 2 July 1934, *Long* 13 (CalA); clay soil four miles north of Stillwater, 6 June 1937, *McLean* 3 (Phila, Texas); 2 miles north of Stillwater, 22 June 1926, *Stratton* 622 (MBG); 23 June 1900, *White s. n.* (RMt); PITTSBURG Co.: rocky woods west of McAlester, 27 May 1920, *Pennell* 10600 (Phila).

TEXAS: western Texas, *Nealley s. n.* (Field); BEXAR Co.: tropical life zone, Leon Spring, 7 June 1911, *Clemens and Clemens s. n.* (CalA, Field); CAMP Co.: Pittsburg 13 September 1923, *Tharp* 2683 (Phila); COMANCHE Co.: De Leon, 12 June 1941, *Tharp s. n.* (Gray); DALLAS Co.: in sandy elm-oak woods near Bachman's Dam, *Lundell and Lundell* 9167 (Gray, SMU) and near Seagoville, in sandy post-oak woods, 1 June 1940, *Lundell and Lundell* 9220 (Gray, SMU); vicinity of Dallas, 3 July 1929, *Stephenson* 96 (US); DENTON Co.: woods, summer 1926, *Harris s. n.* (Texas); in sandy post-oak woods east of Lake Dallas, 13 June 1940, *Lundell and Lundell* 9411 (Gray, SMU, US); GREGG Co.: July 1939, *York s. n.* (Gray, Texas); HOUSTON Co.: 7 July 1926, *Tharp s. n.* (Texas); HUNT Co.: yards and fields, Wolfe City, 9 June 1895, *Turrell s. n.* (Ariz); KAUFMAN Co.: near Mabank in sandy post-oak woods, 20 June 1940, *Lundell and Lundell* 9579 (SMU); KENDALL Co.: Spanish Pass, 11 August 1942, *Parks* Rx2011 and Rx2012 (MBG); KERR Co.: hillside woods, Lacey's Ranch, 1 June 1916, *Palmer* 9994 (MBG, US); NUECES Co.: near Corpus Christi, March 1894, *Heller s. n.* (NY); PARKER Co.: Weatherford, 4 June 1902, *Tracy* 8078 (Field, Gray, MBG, NY, Texas, US); TRAVIS Co.: limestone and black soil near Lake Austin, 27 April 1946 (pre-blooming), *Barkley and Tharp* 46029 (Texas); Austin, 8 November 1922, *Painter* 127 (Texas); Big Walnut Creek, 27 September 1944, Payton 58 (Texas); Austin, 17 August 1922, *Tharp s. n.* (NY) and Austin, 20 July 1940, *s. n.* Gray, MBG, Texas); TARRANT Co.: in sandy post-oak woods between Grapevine and Fort Worth, 17 June 1940, *Lundell and Lundell* 9516 (SMU); open woods, Fort Worth, 21 September 1910, *Ruth* 82 (Field) and in sandy woods, 10 August 1922, 103 (Field, KanSt, Phila); UVALDE Co.: Montell Creek, 10 September 1934, *Cory* 9944 (Gray); WALKER Co.: 12 miles southeast of Huntsville, 28 September 1934, *Cory* 10242 (Gray).

This variety while distinctive shows many intermediates toward var. *longiflora*. The amount of narrowing of the upper leaves on the axis varies considerably among the specimens. There are often corollas about one-half the typical dimensions produced in the lower leaf axils while the main floral production is in the axils of the upper leaves.

21a. RUELLIA CAROLINENSIS (Walt.) Steud. var. SEMICALVA Fernald, Rhodora 47: 73. 1945.

Stems 2-6 dm. tall, simple or with divergent branches from the base, or rarely branched above with floriferous branches, hirsute-puberulent to strigose-puberulent with cystoliths, internodes usually longer than the leaves; leaves 5-9 cm. long, 1.5-3 cm. broad, lanceolate to ovate, subacute to acute at apex, mostly cuneate at the base, lower leaves long-petioled, the upper with shorter petioles, sparsely strigose to puberulent, crenate-undulate to undulate; flowers few, nearly sessile; bracts lanceolate to ovate, acute to acuminate, of similar texture to the leaves; calyx lobes linear, usually conspicuously strigose-ciliate, 1.3-2.5 cm. long; corolla 2.5 to (usually about) 5 cm. long, tube nearly half the length of the corolla throat, limb 2-3 cm. broad; capsules constricted below, brownish, glabrous, about 1.2 cm. long, 3 mm. broad.

Type.—Rich woods, Violet Hill, near Devil's Elbow, Southampton County, Virginia, June 23, 1936, *Fernald, Long and Smart* 5922 in the Gray Herbarium of Harvard University.

Distribution.—Virginia to Florida, west to Texas.

Specimens examined.—LOUISIANA: in woods near Martinsville, 5 May 1893, *Lang-*

Fig. 27.—*Ruellia carolinensis* (Walt.) Steud. var. *serrulata* Tharp and Barkley. Type.

lois s. n. (US); IBERIA PAR.: moist open grassy woods, Avery Island, 11-15 July 1928, *Correll and Correll* 9525 (Gray); ORLEANS PAR.: New Orleans, *Drummond s. n.* and New Orleans 1832 (Gray); ST. TAMMANY PAR.: vicinity of Covington, 5 July 1919, *Anect* 65 (US); vicinity of Covington, 4 June 1920, *Arsène* 12240 (US).

TEXAS.—GREGG CO.: Gladewater, rich sandy woods, 18 June, *Reverchon s. n.* (MBG); HARDIN CO.: 8 miles south of Silsbee, 6 September 1934, *Cory* 11287 (Gray); LIBERTY CO.: low woods, Dayton, 25 May 1915, *Palmer* 7768 (MBG, CalA); UPSHUR CO.: Big Sandy, common in sandy woods, 28 May 1901, *Reverchon* 2536 (MBG); SAN AUGUSTINE CO.: San Augustine, 5 August 1923, *Tharp* 2714 and 2726 (Texas).

This variety on the average has a more robust appearance with larger leaves and flowers than in var. *salicina*. The leaves of this variety are more crenate-undulate than in var. *salacina*. *Drummond* from New Orleans shows much similarity to var. *serrulata*.

21b. RUELLIA CAROLINENSIS (Walt.) Steud. var. SALICINA Fernald, Rhodora 47: 81. 1945.

Stems 2-5 dm. tall, simple or with a few usually short more or less upright usually floriferous branches from the median nodes, spreading-hirsute to hirsute-puberulent or even glabrate, internodes usually longer than the leaves; leaves 4-6 cm. long, 1.2-1.7 cm. broad, broadly lanceolate to lanceolate, mostly sparsely strigose and puberulent, long petioled below, short petioled above; flowers few and sessile in the bract on short axillary peduncles; bracts linear to lanceolate, of similar texture to the leaves; calyx lobes linear, strigose-ciliate, 1.3-1.7 cm. long; corolla 2-4.5 cm. long, tube 1.5-2 cm. long. limb 1.5-2.5 cm. broad; capsules constricted below, brownish, glabrous, 1.3 cm. long, 3.5 cm. broad; seed suborbicular, about 2 mm. in diameter.

Type.—Open ground, Natchitoches Parish, Louisiana, 10 June 1915, *E. J. Palmer* 7945 in the New York Botanical Garden Herbarium.

Distribution.—Indiana and Tennessee to Florida and Texas.

Specimens examined.—Arkansas and Louisiana, *Drummond* (Gray); LOUISIANA: NATCHITOCHES PAR.: open ground, Nachitoches, 10 June 1915, *Palmer* 7945 (US); RAPIDES PAR.: pine barren hills, infrequent, near Alexandria, 6 June 1899, *Ball* 559 (US); WEST CARROLL PAR.: Holly Ridge, 16 July 1903, *Mosely s. n.* (Field).

TEXAS.—HARRIS CO.: Mueller's farm, 20 miles north of Houston, 18 June 1943, *Boon* 213 (Texas); Houston, 9 June 1912, *Fisher* 81 (Calif, US) and 11 May 1913, 2305 (NY); in mud in White Oak Bayou four miles west of Houston, 1940, *Lindheimer* 95 (MBG) and Houston, 1842, *s. n.* (MBG, NY, Gray); TARRANT CO.: rocky hills, Fort Worth, 7 May 1910, *Ruth s. n.* (Texas); TITUS CO.: White Oak Creek, 19 June 1947, *Tharp* 47330 (Texas); UPSHUR CO.: sandy woods, Big Sandy, 28 May 1901, *Reverchon* 2536 (MBG); WALKER CO.: Huntsville, June 1914, *Young s. n.* (Texas); WOOD CO.: damp woods, Mineola, 12 June 1900, *Reverchon* 2113 (MBG).

This variety is very similar to *Ruellia carolinensis* var. *semicalva* and several of the specimens are separated from those of that variety with difficulty.

21c. **Ruellia carolinensis** var. **serrulata** Tharp and Barkley, VAR. NOV.

Caulibus 4-5 dm. altis, filiformibus; internodiis elongatis; foliis angustis, dentatis.

Stems 4-5 dm. tall, simple or branched at the base or very rarely with a few small branches from the lower nodes, puberulent and with cystoliths, internodes much longer than the leaves; leaves 3.5-5.5 cm. long, .7-1 cm. broad, linear-lanceolate, acute to acuminate at apex, cuneate at base, long-petioled, serrate-undulate to merely undulate, puberulent to glabrate; bracts linear-lanceolate, acuminate, cuneate at base, similar to the leaves in texture; flowers few in the axils of most of the leaves, sessile or the flower glomerule on a very short peduncle, calyx lobes linear, 1-2 cm. long, inconspicuously ciliate and puberulent and with cystoliths; corolla about 3 cm. long, tube about 1.5 cm. long, limb about 2 cm. broad; capsules constricted below, brownish, glabrous, 1.1 cm. long, .3 cm. broad.

Type.—Beaumont, Jefferson County, Texas, 10 Sept. 1937, *B. C. Tharp s. n.* in the Herbarium of the University of Texas.

Distribution.—Eastern Texas.

Specimens examined.—TEXAS: BRAZORIA CO.: Columbia, common in woods, 18 October 1900, *Bush* 1572 (MBG), argillaceous banks, Columbia, 3 October 1914, *Palmer* 6714 (Field); JEFFERSON CO.: Beaumont, 10 September 1937, *Tharp s. n.* (Texas); UPSHUR CO.: damp sandy soil, Big Sandy, 15 September 1902, *Reverchon s. n.* (MBG); VAN ZANDT CO.: near Grand Saline, 3 July 1939, *Williams* 7 (NTex).

Bush 1572, *Palmer* 6714 and *Williams* 7 show considerable similarity to *Ruellia humilis* var. *depauperata.*

22. RUELLIA DRUMMONDIANA (Nees) Gray, Syn. Fl. N. Am. 2: 326. 1886.

Dipteracanthus Drummondianus Nees in DC., Prodr. 11: 197. 1847.

D. Lindheimerianus Scheele in Linn. 21: 764. 1848.

Plant perennial from a short subligneous rhizome, many rooted from the nodes of the rhizome; stems about 65 cm. tall, tending to be four-angled, puberulent and sparsely softly pilose, branching, the branches tending to be delicate, straight and ascending, tending to produce glomerules at all the nodes that no not bear branches; leaves ovate but rarely broadly so, undulate margined, tapering to the acute (or rarely obtuse or subacuminate) apex, tapering to the cuneate base, the larger leaves with laminae 5-8 cm. broad, 10-14 cm. long, and with ptioles about 1.5 cm. long, darker and sparsely appressed-pubescent above, lighter and sparsely pilose beneath, rarely leaves of lateral branches only 1/2 - 1/3 as large and then suborbicular, obtuse to rounded at apex and very broadly cuneate at base; glomerules lateral usually short peduncled with two oval bracts whose blades are about 7 mm. long and 5 mm. broad, on petioles about 2 mm. long, flowers 2-7; calyx lobes gradually tapering into subulate tips, 12-35 mm. long, those of some flowers much longer than in others, white pilose-pubescent; corolla 3.2-4.2 cm. long, tube about as long as the throat, limb 1.5-2.5 cm. broad, lavender, lobes undulate-margined, about half as long as the breadth of the limb; fruit short-pedicellate about 1.1 cm. long, 4 mm. broad, minutely canescent, style-base tending to be persistent as a long point; seed with white appressed pilosity, 5 mm. in diameter.

Type.—Texas, *Drummond*, 260 in the Gray Herbarium of Harvard University.

Distribution.—Central Texas.

Specimens examined.—TEXAS: *Drummond* 260 (Gray, NY); western Texas, *Jermy* 61 and *s. n.* (MBG); shady bottoms of the Blanco, June-August, *Wright s. n.* (KanSt); BELL CO.: Belton, 23 August 1929, *Whitehouse s. n.* (Texas); along Salado Creek, 20 September 1932, *Wolff* 3606 (Tracy); BEXAR CO.: common in woods near San Antonio, 2 October 1900, *Bush* 1214 (MBG, NY, US); tropical life zone, San Antonio, 6 June 1911, *Clemens* 1058 (MBG, RMt); upper San Antonio River, 8 September 1900, *Eggert s. n.* (MBG); in sandy and gravelly soil, 3 August 1903, *Groth* 161 (CalA, Field, Gray, NY, US); Breckenridge Park, San Antonio, September 1906, *Headley s. n.* (US); *Jermy* 61 (US), 1904, 39 (NY), 102 (US) and San Antonio, 265 (Gray); shady woods, San Antonio, 15 October 1910, *Mackenson* 20 (MBG); San Antonio, 5 September 1920, *Schulz* 187 (US); COMAL CO.: rocky woodlands, New Braunfels, 12 September 1903, *Biltmore Herbarium* (US); 1845, *Lindheimer* 323 (268) (NY), 1846, 506 (Calif, Gray, Paris), New Braunfels, August 1846, 323 (506) (MBG), 1846, 506 (NY, Phila, US), Comanche Spring, New Braunfels, August 1850, 1064 (Ariz, Calif, Field, Gray, IBM, MBG, NM, NY, Okla, Phila, Texas, US) and New Braunfels, August 1850, 351 (KanSt); infrequent beneath oaks in Landa Park, Comal Springs in New Braunfels, 6 July 1946, *Warnock* 46501 (Texas); GILLESPIE CO.: Pedernales, *Jermy* 720 (MBG, US); GONZALES CO.: Palmetto State Park, 29 June 1946, *Albers* 16T486 (Texas); GUADALUPE CO.: Capote Hills, 9 September 1933, *Tharp s. n.* (Texas); HAYS CO.: San Marcos and vicinity, spring 1898, *Stanfield s. n.* (NY); KERR CO.: Kerrville, shaded rocky bluffs, 9 June 1917, *Palmer* 12211 (MBG); north of Hunt, 7 June 1929, *Whitehouse s. n.* and 3 July 1933, *Whitehouse s. n.* (Texas); TRAVIS CO.: Limestone and black soil near Lake Austin, 27 April 1946, *Barkley and Tharp* 46028 (Texas); Austin, *Dapprich* 7417 (SMU); rocky limestone soil in stream bed above Barton Springs, 3 August 1946, *Krodel* 33 (Texas); Austin, August 1882, *Letterman* 59 (MBG, US); Austin, 22 November 1922, *Painter* 126 (Texas), Austin 1923, 83 (KanSt), Austin, 6 October 1923, *Painter s. n.* (NY) and 415 (Phila, Texas) and slope east of Austin, 13 November 1923, 377 (Texas); Big Walnut Creek 7 miles north of Austin, 15 October 1944, *Payton* 34 (Texas); shaded river bottom at Austin, 8 August 1921, *Schulz* 613 and Austin, August 1921, 637 (US); Lake Austin, 6 August 1936, *Tharp s. n.* (Calif, Gray, MBG, SMU, Texas) and Colorado River Bluff near Austin, 2 August 1941, *Tharp s. n.* (Clokey, Gray, MBG, SMU, Tracy); in shade near lower Bull Creek, 8 July 1946, *Tharp, Oualline and Barkley* 16T467 (Texas); Shoal Creek, Austin, 13 November 1915, *Young s. n.* (NY, Texas); infrequent below limestone bluffs along upper Bull Creek 7 miles norhwest of Austin, 3 October 1945, *Warnock* 45-33 (Texas); Austin, 17 October 1930, *Whitehouse s. n.* (Texas); WILLIAMSON CO.: along base of cliff beside Brushy Creek bottom north of Round Rock, 8 August 1946, *York* 46274 (Texas); UVALDE CO.: 5.5 miles east of Reagan Wells, 16 August 1937, *Cory* 23929 (Gray).

The Shadscale Vegetation Zone of Nevada and Eastern California in Relation to Climate and Soils[1]

W. D. Billings

University of Nevada, Reno

CONTENTS

Introduction

In the intermountain region of the western United States, great expanses of small-leaved shrubby vegetation occupy the semi-arid and arid valleys and foothills between the isolated mountain ranges. The dominant shrubs, principally members of the Compositae and Chenopodiaceae, are relatively low in stature, ranging in height from less than one to four or five feet in height. This vegetation has been designated as constituting the main body of the sagebrush formation or climax (Clements, 1920; Weaver and Clements, 1938).

Clements (1920) considers this formation to be made up of two associations. One association, the *Atriplex-Artemisia* association or basin sagebrush, occupies that area between the Sierra Nevada and the Rocky Mountains known as the intermountain region. This corresponds to the Great Basin Desert area of Shreve (1942). The principal dominants of this association are, according to Clements, sagebrush (*Artemisia tridentata*)[2] and shadscale (*Atriplex confertifolia*). The other association, much smaller in extent, is designated the Salvia-Artemisia association or coastal sagebrush and is restricted to the coastal mountains of central and southern California. Clements' descriptions of the basin sagebrush association are rather general in nature and make no real attempt to analyze its structure. However, many vegetational types within this large association have long been recognized and there exists a long series of papers describing the types with particular reference to their soil relationships (Kearney et al., 1914; Shantz, 1924, 1925; Shantz and Piemeisel, 1940; Flowers, 1934; Shreve, 1942; Billings, 1945; and Fautin, 1946, among others). The community taxonomy proposed by these papers has been quite varied. This has been due partly to differences in geographic location of the research areas and partly to differences in approach to such classification.

1 The research upon which this paper is based has been aided, in part, by a grant from the Research Committee, University of Nevada.

2 The nomenclature in this paper follows Munz (1935) insofar as the species are included by him.

The problem of the structure of this shrubby vegetation will be approached in the present paper from the standpoint of zonation. The basin sagebrush association of Clements is readily divided into two zones on the basis of macroclimate. Each zone is a vegetational mosaic consisting of a climax matrix community in which are embedded various edaphic communities. The relatively warmer and drier zone is here designated the shadscale zone with a matrix characterized by the almost universal presence of *Atriplex confertifolia*. The other, which can be called the intermountain sagebrush zone, is dominated principally by *Artemisia tridentata*. It is the purpose of this paper to analyze

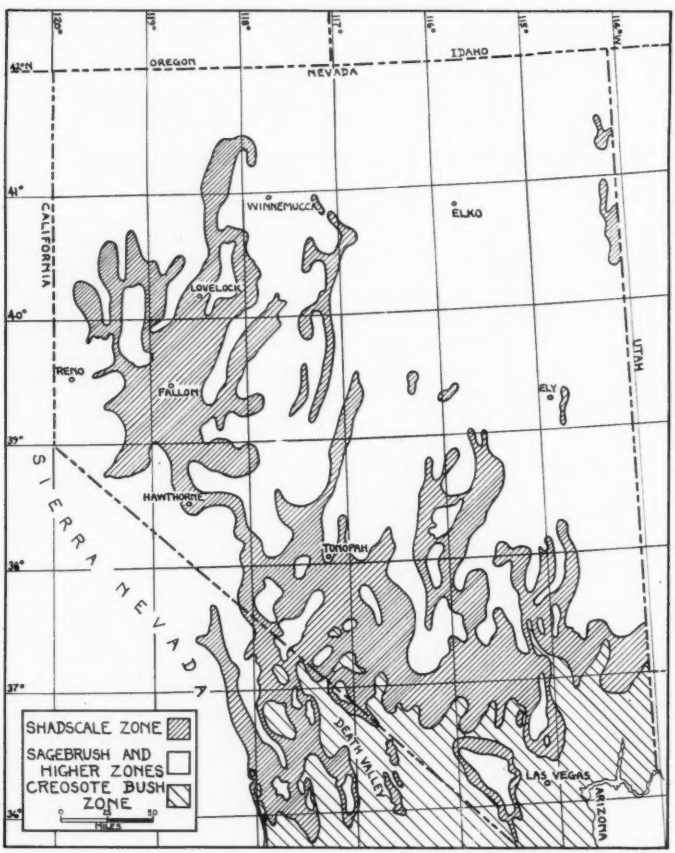


Fig. 1.—The areal extent of the shadscale zone in Nevada and eastern California.

and describe the shadscale zone, as a vegetational unit, in relation to climate and soils.

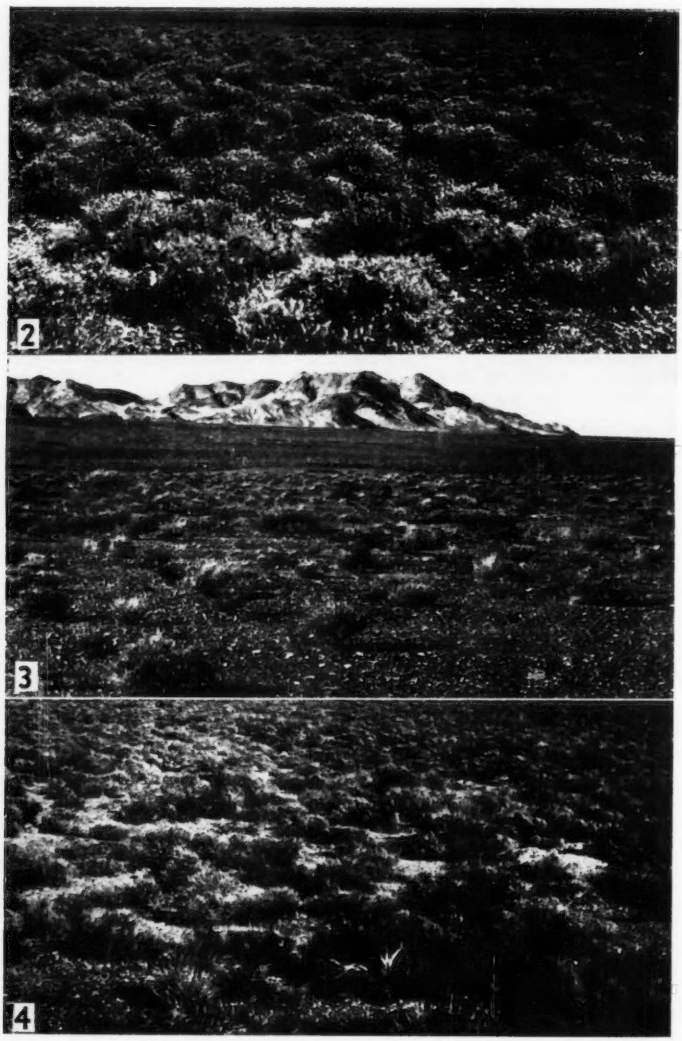
DISTRIBUTION AND APPEARANCE

Due to rugged topography and somewhat varied climate, shadscale vegetation is distributed rather irregularly throughout the formation. Since it is correlated with a drier, warmer climate than that of the sagebrush zone, it occurs mainly toward the southern and southwestern parts of the intermountain region. The largest continuous area of the shadscale zone extends from the Carson Desert of west-central Nevada south and east to the dry mountain ranges of the Death Valley region and southern Nevada. The general limits of this shadscale zone as it occurs in Nevada and eastern California are shown by the map in Figure 1. No attempt has been made to map the limits of the zone east of the Nevada-Utah state line. Within the zone, the climax vegetation is a mosaic with its matrix being the shadscale association with all of its climatic and edaphic variations. As can be seen, shadscale vegetation in this part of its range forms a distinct zone between the sagebrush zone to the north and the creosote bush zone to the south. In the southern mountain ranges, these same zones appear as altitudinal belts with shadscale separating the sagebrush above from the creosote bush below.

A second large area of shadscale vegetation lies in the arid portions of western Utah. This is the smaller of the two main areas of the zone and the locale of almost all of the published data on the association. Numerous isolated islands of shadscale vegetation occur between and to the north of the two main areas, extending into eastern Oregon and southern Idaho. There is also a less well-known area of shadscale vegetation in the Green and Colorado River drainages of eastern Utah and western Colorado (Clements, 1920; Graham, 1937).

The general appearance of the climax shadscale matrix as it occurs at widely separated points is illustrated by the photographs in Figures 2 to 4. They show the typical uniform physiognomy which this community exhibits. In contrast, Figure 5 illustrates a typical sagebrush type.

The principal shadscale dominants (*Atriplex confertifolia, Artemisia spinescens, Sarcobatus baileyi, Ephedra nevadensis,* and *Lycium* spp.) are widely scattered, small (½ to 2 feet high), more or less spinescent, microphyll shrubs. The ground covered by these shrubs is almost always less than ten per cent of the total area of the stand. Ground covered by the shrubs in the sagebrush association usually ranges from fifteen to forty per cent. In the typical shadscale matrix, the soil between the shrubs is nearly devoid of herbaceous plants except for an occasional clump of *Oryzopsis hymenoides* or *Sphaeralcea ambigua* and the sparse, minute native annuals present for a few weeks in a moist spring. On lighter soils, especially where protected from grazing, there is often a better development of the perennial herbaceous flora. In western Nevada and eastern California, the barren expanse between the shrubs is almost always covered with a desert pavement of small to large rocks. This characteristic pavement is the result of centuries of wind and water erosion and is



Figs. 2-4.—2. Typical shadscale vegetation in northern part of zone in Buena Vista Valley, Pershing County, Nevada; 3. Typical shadscale vegetation in middle part of zone east of Monte Cristo Range, Esmeralda County, Nevada; 4. Typical shadscale vegetation in southern part of zone in Towne's Pass, Panamint Range, Inyo County, California.

usually dark with "desert varnish" in contrast to the light grayish soil beneath. Figures 3 and 4 show good examples of desert pavement.

RELATION TO CLIMATE

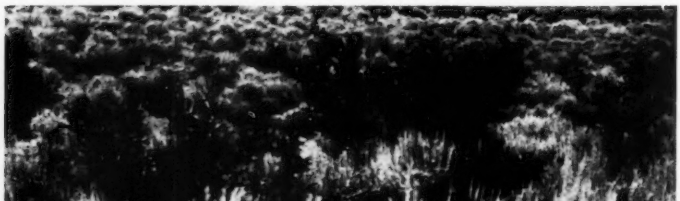
Until recently, it was believed that shadscale vegetation dominated by *Atriplex confertifolia* was always indicative of edaphic situations characterized by subsoil salinity coupled with relative dryness. This impression resulted primarily from the fact that most of the investigations of the shadscale community were made in Utah along the moister eastern edge of the formation. In that area, shadscale usually does indicate such a soil. Shantz (1924), however, pointed out briefly that shadscale over much of the southern part of the intermountain area occupies land which is too dry for sagebrush. Billings (1945) described the shadscale-little greasewood (*Sarcobatus baileyi*) community in western Nevada as occupying not only the dry lake-laid sediments with mild concentrations of subsoil salt, but also the dry salt-free residual and fan soils of the foothills and lower mountain ranges where the precipitation is under six inches per year. This shadscale-little greasewood vegetation was considered to be a climatic climax in the arid trough of the Carson Desert east of the Sierra Nevada in a region too dry to be dominated by sagebrush. Fautin (1946) has pointed out that even in the eastern part of the formation, shadscale may indicate climatically dry areas as well as physiologically dry soils.

The relationship between the presence of *Artemisia tridentata* and higher available soil moisture is shown in many places in the northern part of the shadscale zone. Galeria communities of sagebrush extend down into the shadscale vegetation along nearly every drainage channel. Figure 6 illustrates how delicately this moisture factor may be balanced. When the maintenance of the shoulders was discontinued along an abandoned stretch of paved road the additional water supply running off the pavement allowed the invasion of sagebrush from the nearby foothills.

With the approximate geographic limits of the shadscale zone delineated, it becomes possible to compare its climatic characteristics with those of the adjacent sagebrush zone. In general, it can be said that the climate of the shadscale zone is distinctly drier and a little warmer than that of the sagebrush zone. Evidence to illustrate this is presented in Tables I and II. The data are from Sager (1932, 1941).

At 11 stations in the shadscale zone in western Nevada and eastern California, the mean annual precipitation ranges from 3.08 inches at Thorne, Nevada, to 5.68 inches at Schurz, Nevada, with an average of 4.51 inches for the zone. On the other hand, at 6 stations in the sagebrush zone in northern and western Nevada the mean annual precipitation ranges from 7.73 inches at Reno to 9.46 inches at Elko with an average for the zone of 8.79 inches. This is almost twice that for the shadscale zone. The precipitation regime for both zones in the western part of the formation shows a winter maximum and a summer minimum, the summers being almost rainless.

Precipitation for the two zones as they occur in western Utah and reported by Fautin (1946) is somewhat higher than for the western part of the formation. The mean annual precipitation for six shadscale stations in western Utah was found to average 7.95 inches, while that for four sagebrush stations averaged 14.84 inches. Here also it will be noted that the average precipitation



Figs. 5-6.—5. Typical sagebrush vegetation with *Artemisia tridentata* and *Purshia tridentata* (dark shrubs) on eastern foothills of Carson Range, Washoe County, Nevada; 6. Large plants of *Artemisia tridentata* growing on abandoned road shoulder surrounded by shadscale vegetation, Pershing County, Nevada.

of the sagebrush zone is almost twice that of the shadscale zone. The summer dry period is not so well marked in this eastern part of the formation because of the occurrence of relatively heavy convectional precipitation during July and August.

The mean January temperatures for 9 shadscale stations in the western region range from 29.2° F. at Lovelock, Nevada, to 39° F. at Independence, California, with an average for the zone of 33.6° F. The mean January temperatures for the sagebrush zone in northern and western Nevada range from 24.4° F. at Elko to 32.5° F. at Reno, with an average for the zone of 29.05° F. The summer temperatures of the shadscale zone in the western part of the formation are distinctly higher than those of the sagebrush zone. The July means in the shadscale zone range from 70.5° F. at Yerington, Nevada, to 78.3° F. at Independence, California, with an average of 75.1° F. for the zone. The mean July temperatures in the sagebrush zone in the same part of the formation range from 68.6° F. at Carson City, Nevada, to 71.9° F. at Winnemucca, Nevada, with an average for the zone of 70.1° F. or five degrees cooler than that of the shadscale zone. The higher summer temperature for the shadscale zone is undoubtedly reflected in higher evaporation resulting, when coupled with the lower precipitation, in greater aridity. Fautin (1946) shows that in the eastern part of the formation, summer temperature conditions in the two zones are very similar. For example, the mean July temperatures at six stations in the shadscale zone in western Utah averaged 73.7° F., while the figure for four stations in the sagebrush zone was 74.6° F.

Russell (1931), in his revision of the Köppen climatic classification for the dry climates of the western United States, indicates by his map that most of the region here recognized as the shadscale zone is classified as cold desert (BWks) with a summer deficiency of precipitation. Most of the sagebrush zone is designated as cold steppe climate (BSks). The shadscale zone is thus seen to be the vegetational product of the relatively small cold desert area in the western United States, lying between the sagebrush with its cold steppe climate on the north and the creosote bush characteristic of the warm desert (BWhs) on the south. Thornthwaite (1941) shows precipitation-effectiveness indices of below 16, or arid, for much of the shadscale zone, while the sagebrush zone lies principally in the semi-arid belt with indices ranging from 16 to 31.

RELATION TO SOILS

It has been generally understood among ecologists that shadscale vegetation is usually indicative of soil which is somewhat saline below the first foot (Weaver and Clements, 1938) and dry in summer. This was first shown by Kearney and his coworkers (1914) in the Tooele Valley of Utah. In the Tooele Valley, shadscale soils were found to have between 0.5 and 1.0 per cent salt below the second foot. This subsoil salinity and dryness of soil in summer under shadscale has been verified many times since then, notably by Flowers (1934), Stewart, Cottam, and Hutchings (1940), and Shantz and Piemeisel (1940) in Utah, and in some, but not all, shadscale areas in western Nevada by Billings (1945).

The relations between shadscale vegetation and subsoil salinity have often obscured the relationship between shadscale and climate. Kearney et al. (1914), in a footnote, pointed out that outside the Tooele Valley, shadscale is not confined to areas with a saline subsoil, but may be found on dry gravelly soils where conditions are too dry for sagebrush. Clements (1920), Shantz (1924), Billings (1945), and Fautin (1946) have also questioned the universal association of shadscale and subsoil salinity.

As a check upon the reliability of shadscale as an indicator of subsoil salinity, conductance of duplicate samples of soil solution filtrate was determined for soil profiles in 7 shadscale stations and 3 sagebrush stations by standard methods. The average conductance of these filtrates is expressed as $K \times 10^5$ in Table III. The degree of salinity is considered to be directly proportional to the value of $K \times 10^5$.

Some shadscale stations show clear evidence of saline subsoils. Two of these, Stations 4 and 5, are on Lahontan sediments, while Stations 6 and 7 are on alluvial fans. Stations 1 and 2 show no evidence of accumulation of salts to the depths of 100 centimeters, while Station 3 shows no accumulation to a depth of 70 centimeters, the extent of the profiles. The soil salinities of the first three shadscale stations are not apparently different from those of the three sagebrush stations. It appears that shadscale vegetation is not always a reliable indicator of saline subsoils in the western part of the zone. This is particularly true on the better-drained soils. The presence of salts in the deeper layers of the heavier soils may indicate the zone of maximum percolation of soil moisture during the winter.

The general characteristics of zonal shadscale soils in regard to texture and pH are shown for three stations in Table IV. The surface soils in all three stations are sands with a high proportion of rock. This rock tends to accumulate near the surface as erosion removes the surrounding soil. The result is a desert pavement which is characteristic of much of the shadscale matrix. Sagebrush land generally has only a weakly developed pavement or none at all. The subsoils under shadscale range from sands to clay-loams depending upon the parent material. There appears to be no consistent textural difference between sagebrush soils and shadscale soils; either may possess subsoils which range from sands to clays.

Where shadscale vegetation occupies deep sands in the western part of the zone, the sands are probably not of aeolian origin but are water-deposited in lake sediments, alluvial fans, or bajadas. This is evidenced by the almost universal presence of some gravel and rock larger than 2 millimeters in diameter throughout the profile. The stabilized dune sands of this part of the zone are occupied by the *Dalea* community (Billings, 1945).

In the eastern part of its range, the shadscale association occurs principally on the heavier soils of the playas (Kearney et al., 1914; Shantz and Piemeisel, 1940), but also occupies foothill areas where saline hardpans occur at depths of 1 to 2 feet (Stewart, Cottam, and Hutchings, 1940). The latter authors are of the opinon that the shadscale plant is better able to stand physiological

drought than physical drought and that its preferred habitat in western Utah is the playa with its higher soil moisture.

The soils of the shadscale association in western Nevada are distinctly alkaline at all depths. Sagebrush soils, on the other hand, are often neutral or even slightly acid in the upper portion of the profile while the subsoil is usually alkaline.

Shadscale soils may or may not show a prominent hardpan (Kearney et al., 1914; Shantz and Piemeisel, 1940). In many shadscale locations in the western Great Basin, a distinct pan layer about 10-15 centimeters in thickness begins from 10-20 centimeters below the surface. In almost all cases, this pan is not very strongly cemented and does not seem to impede the growth of the shrub roots to any extent. Qualitative tests for the presence of carbonates in the profiles show that under shadscale the carbonates may be located principally in the pan layer or may be present throughout the whole profile. Under sagebrush in western Nevada, the principal depth of the carbonate layer seems to be between 60 and 80 centimeters below the surface, although it may occur above this or be seemingly absent. The top of the carbonate layer under sagebrush is usually cemented into a pan which is quite hard and relatively impenetrable. The relatively greater depth of the carbonates in the sagebrush zone is additional evidence of its moister climate.

The soils of the shadscale zonal matrix appear to be, for the most part, typical gray desert soils with carbonates accumulating not far beneath the surface. The soils are almost always light in color, ranging from an ashy gray to a light buff. It seems possible that the presence of salts in the subsoil may be a rather common characteristic of gray desert soils depending upon the origin of the parent material and the relative weakness of leaching. Sagebrush zone soils have generally been referred to the gray desert soil group (Marbut, 1935). This perhaps is true for the greater part of the zone. However, in western and northwestern Nevada most sagebrush soils are distinctly brown in color and show a relatively deep carbonate layer if one is present at all. Many of these sagebrush soils appear to be more characteristic of the brown soil groups.

STRUCTURE OF THE VEGETATION

Before proceeding to a discussion of the ecological classification of the shadscale zone, it is necessary to describe its structure with special reference to its relationships with sagebrush vegetation. For these purposes, it is well to consider each zone as consisting of a climatic matrix in which are embedded various edaphic communities, the so-called "edaphic climaxes."

In the course of this investigation, the vegetation of the shadscale matrix was studied at a number of widely scattered points in Nevada and eastern California. At 35 stations, species lists were compiled. For the benefit of future investigators, the exact locations of these stations are given in Table V. Table VI lists the presence of woody plants as they occur in the matrix at these locations. In addition to the presence lists, 12 of the stations were

selected for quantitative sampling. At each of these latter locations, 10 to 25 quadrats of 10 square meters each were evenly distributed through the vegetation at arbitrary intervals. On each quadrat, the number of individuals and percentage of ground covered were listed for each woody species. These quantitative data appear in Table VII. Comparable data, gathered in the same manner, at 4 stations in the sagebrush zone appear in Table VIII.

From these data, the matrix of the shadscale zone is seen to be a community of low spiny shrubs dominated almost everywhere by *Atriplex confertifolia* and *Artemisia spinescens*. In the western part of the zone, the little greasewood, *Sarcobatus baileyi*, is also of very great importance, making up over half of the total shrubby cover in many locations. This matrix community is designated the shadscale association since, with a presence of 97%, this species is almost universally present. Reference to the data of Fautin (1946) indicates that this community is quite similar to that occupying the eastern part of the zone.

In contrast, the matrix of the sagebrush zone is dominated by larger, primarily non-spiny shrubs. By far the most important dominant is the sagebrush, *Artemisia tridentata*, which makes up from 60 to 95 per cent of the total shrubby cover at any station. The sagebrush matrix, like the shadscale, varies slightly from one part of its range to another. At its lower rainfall limit in the broad valleys of northwestern Nevada, it is often present in almost pure stands, while near the upper edges of the zone, *Purshia tridentata*, and other shrubs become important. It is very possible that *Purshia* was once more widely distributed throughout the sagebrush matrix than at present because of its extremely slow regeneration after fire.

The shadscale community, reflecting the lower precipitation in that zone, shows a very low percentage of the ground covered by shrubs. At the stations investigated, this percentage ranged from 4.05 per cent to 11.86 per cent and averaged only 6.95 per cent. The sagebrush community, on the other hand, exhibited almost three times as much shrubby cover at the stations listed, averaging 18.39 per cent of the ground covered. Under favorable conditions, sagebrush may show even higher coverage. Because of the smaller size of the shrubs in the shadscale association, it is not surprising to find that this type of vegetation shows an average of 16.8 woody plants per 10 square meters while sagebrush averages only 11.7 shrubs for the same area.

Since the composition of the herbaceous strata of the shadscale association has been rather completely reported previously (Billings, 1945), only a résumé will be given here. The non-woody part of the shadscale community is usually quite sparse. It consists of a few scattered perennials and the ephemeral annuals which may be present in the spring if soil moisture is sufficient. The principal perennial herbs in the shadscale community are *Oryzopsis hymenoides, Sphaeralcea ambigua, S. grossulariifolia, Hilaria jamesii, Stipa speciosa,* and in the western portion of the zone, *Hermidium alipes*. The principal annuals are small and delicate and are best typified by *Cryptantha circumscissa, C. micrantha, Eriogonum vimineum, Glyptopleura marginata, Oeno-*

thera clavaeformis, and *Festuca octoflora* var. *hirtella. Eriogonum inflatum* is frequent in the southern part of the zone.

The paucity of the herbaceous vegetation may be due in large part to the effects of heavy grazing in the past. This use has been principally as winter range for sheep but with some utilization by cattle and horses where water is available. Stewart, Cottam, and Hutchings (1940) have shown that unrestricted grazing in shadscale-grass vegetation in western Utah has almost eliminated the grass because of its relatively higher palatability. A similar situation probably has prevailed over much of the western part of the zone although there is little concrete evidence to prove it. There are no experimental exclosures in typical shadscale matrix vegetation in western Nevada. However, there are at least two exclosures maintained jointly by the United States Forest Service and the University of Nevada Agricultural Experiment Station that are located in the ecotone region between the shadscale and sagebrush zones. Both of these are in heavily grazed areas and show remarkable recovery (in 11 years) of the highly palatable *Oryzopsis hymenoides* and *Eurotia lanata.* It is possible that exclosures in many places in the shadscale matrix would show similar results. On the other hand, there are numerous areas in the matrix where grazing has not been important for many years or which were never grazed. Even in these places, with *Oryzopsis* scarcely utilized or not at all, the shrubs are almost everywhere dominant and the grasses scattered and small. In some places, however, where grazing is absent or light, grasses do make up a fairly large part of the community. At Station 26 in the foothills at the south end of the White Mountains, large clumps of *Stipa speciosa,* desert needlegrass, were abundant over the steep slopes occupied by the shadscale community.

The shadscale zone has been very little affected by the invasion of the annual bromes (*Bromus tectorum, B. rubens*) which have replaced so much of the native herbaceous flora in the sagebrush zone through overgrazing and fire. The bromes are restricted in the shadscale zone to the outer, moister edges and throughout almost all of the zone are absent. The precipitation appears to be too low for them without elimination of the native flora by overgrazing. As a result, fire is rare in the shadscale zone while it is a very important factor at present in the sagebrush zone.

Within the climatic matrix of the shadscale zone are several prominent edaphic communities. These "edaphic climaxes" are permanent communities determined by soil conditions within the limits set by climate. Since the vegetation and soils of these communities have been analyzed and described before, this paper will not go into their detailed structure and the soil conditions which they indicate. Reference is made to the papers of Kearney et al. (1914), Flowers (1934), Shantz and Piemeisel (1940), and Fautin (1946) for the eastern part of the zone and Billings (1945) for the western part of the zone. It will be sufficient to point out that at least four of these shrubby edaphic climaxes are found throughout the shadscale zone. These are the big greasewood (*Sarcobatus vermiculatus*), the big greasewood-shadscale, the pickleweed

(*Allenrolfea occidentalis*), and the winterfat (*Eurotia lanata*) communities all of which are associated with soils of some salt content. Dune sands in the western or Lahontan portion of the zone are covered by a *Dalea polyadenia-Tetradymia comosa* community. Such sands in the eastern or Utah area may be populated by communities dominated by *Tetradymia glabrata* or by little rabbitbrush, principally *Chrysothamnus stenophyllus*. A little rabbitbrush community may also be the result of disturbance where it has invaded winterfat, shadscale or other land which has been overgrazed. Little rabbitbrush communities of this latter type are quite common in the valleys of eastern Nevada and western Utah.

That the dominant species of the edaphic communities are related to those of the shadscale matrix is readily seen by the presence of the predominant Chenopodiaceous and Composite genera: *Sarcobatus, Atriplex, Eurotia, Tetradymia,* and *Chrysothamnus*. While these edaphic "tiles" are climax in their own right, relationship ties them into the whole mosaic with its matrix of shadscale.

PROBLEMS OF COMMUNITY CLASSIFICATION

It has been customary in describing vegetation to attempt to assign it rank in one or another system of vegetational classification. Such systems have varied widely with the diverse views of the investigators. All ecologists agree upon the existence of concrete association-individuals or stands. However, doubt that an association exists as a real entity over considerable area has been expressed by Gleason (1926, 1939), and more recently by Cain (1947) and Mason (1947). They view the association as being individualistic and the result of coincidence of environmental requirements of its several component species.

The problem of classification of shadscale vegetation is, of necessity, tied up with this question of the objective reality of the association over a large area. The statistical data on composition in Tables VI and VII show that no two stations in shadscale vegetation are alike. The floristic pattern of the matrix varies in a more or less continuous manner within the limits of the zone. On the other hand, comparison of these data with those from sagebrush (Table VIII) indicates that there is a discontinuity between the two vegetations greater than any variation within either. This discontinuity is not only floristic but also physiognomic. It may occur geographically over a broad or narrow ecotone depending upon the degree of variance in the environment.

Shadscale vegetation seems to be a natural and recognizable unit. However, the ties between the members of this unit appear to be weak and due principally to what Mason (1947) has called "coincidence of tolerance." An examination of the geographic ranges (Figure 7) of the 7 woody species with the highest presence percentages (Table VI) reveals that all but one extend far beyond the extent of typical shadscale vegetation. Each range is different and independent of any other. The area of overlap where the environment

is suitable for all is relatively small and corresponds closely to the region of most typical development of shadscale desert vegetation.

Graham (1944) and Cain (1947) have advocated the use of the term "natural area" as a useful designation for a region with marked biological characteristics. While incapable of exact definition, a natural area, according to Cain (1947), ". . . is a geographic unit of any order of size with sufficient common characteristics of various sorts to be of some practical usefulness in biogeography." The shadscale desert could certainly be considered a natural area.

Perhaps it is possible to become slightly more precise while still recognizing the universal variation in vegetation. It would be desirable if some use could be made of the concept of zonation, especially as brought out as "life zones"

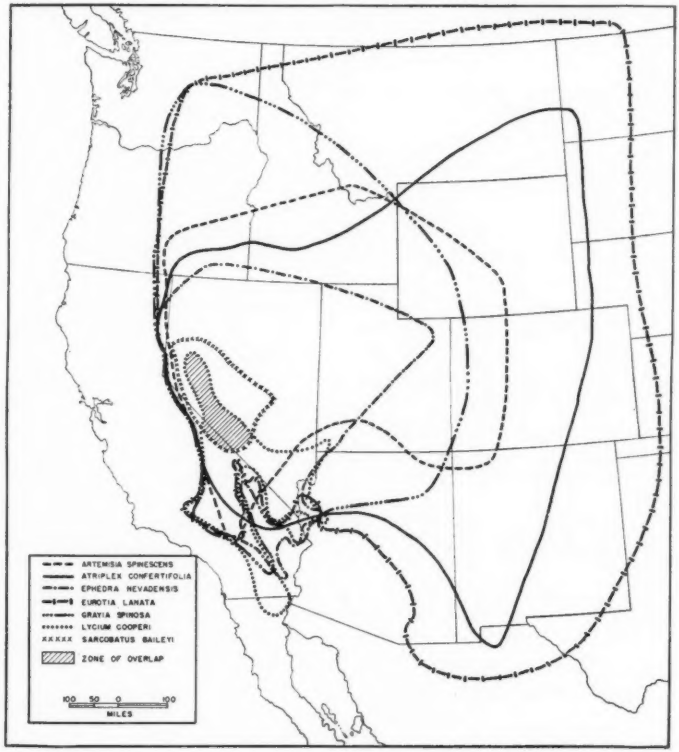


Fig. 7.—Approximate ranges of the seven most important shrubby species of the shadscale zone. Note relatively small zone of overlap.

in the earlier work of Merriam (1890). Unfortunately, the term "life zone" came to be defined by temperature alone and not by recognition of the biota. Such an artificial condition led Daubenmire (1946) to recommend the use of climax vegetation in the recognition of life zones, such zones then to be designated "vegetation zones." Daubenmire views the vegetation zone as consisting of a matrix of zonal vegetation governed largely by climate surrounding islands of interzonal vegetation which are controlled primarily by edaphic conditions. These ideas on zone structure are essentially the same as those expressed by the author (Billings, 1946) in regard to the structure of climax desert vegetation. The matrix community of the shadscale desert occurs on zonal soils of mixed mineralogical composition and is made up of species of wide environmental tolerances with the dominants having similar life-form. Species with narrower tolerance ranges, in general, make up the interzonal vegetation of the edaphic "islands" embedded in the matrix.

While acknowledging the individualistic nature of each stand of shadscale vegetation and recognizing the independent distribution of each component species, it yet seems possible to recognize the shadscale desert as an entity, a vegetation zone. Admittedly, the recognition must be somewhat arbitrary, but perhaps if extensive vegetational units are to be recognized at all, their boundaries must be defined in an arbitrary manner. Physiognomy of the dominants is as important in the setting apart of a zone as is floristics. A vegetation zone thus delimited, its shortcomings recognized, would be of much practical use as a basis for many types of biological field studies. La Rivers (1948) has recently shown, for example, that certain Orthoptera are restricted to the shadscale zone, others to the sagebrush zone, while some are found in both.

While physiognomic discontinuity may be the key to the delimitation of zones, there will remain the problem of how to dispose of the ecotone regions. Ecotone regions exist, whether narrow or broad, and their existence will have to be recognized for what they are, i.e., not a part of either zone but the product of both. Since the shadscale zone is primarily a climatic phenomenon, it is to be expected that its ecotones with the two major adjoining zones, sagebrush and creosote bush, will be fairly wide except on the sides of fairly steep mountain ranges. As a result, it is not possible to draw a sharp boundary delimiting the zone. On the map in Figure 1, the boundary lines are, of course, approximate but are as accurate as is possible under the existing conditions.

In addition to its relations with the sagebrush and creosote bush zones, other boundary phenomena of the shadscale zone are of interest. In the northern part of its range, for example, it is found primarily in the valleys and low gentle slopes surrounding these valleys. Here, of necessity, it usually occupies the drier saline soils of these valleys and is representative of conditions of physiological drought. In the southern part of its range, however, it inhabits steep mountain sides and even the crests of the lower mountain ranges as illustrated by its presence on the Black and Funeral Ranges to the east of

Death Valley. These are sites of excellent drainage in a very arid region and here the association is indicative of climatic drought.

Along this southern border of the zone, the Joshua tree, *Yucca brevifolia*, is occasionally found forming open groves through the shadscale matrix. The *Yucca* seems to be an ecotone species since it is not confined to the shadscale zone but is also found in the edges of the creosote bush zone on one side and in the sagebrush and even the pinyon-juniper zones where these latter zones become narrow on the sides of the more southern mountain ranges.

The southeastern boundary of the shadscale zone is the most difficult to detect. Eastward from the Charleston Range in southern Nevada, shadscale vegetation seems to be replaced by a community chiefly characterized by blackbrush, *Coleogyne ramosissima*, and certain other shrubs. The extreme southeastern portion of the shadscale zone as shown in Figure 1 is actually occupied by this mixed or often pure blackbrush vegetation. Like the shadscale, it is an intermediate zone between sagebrush and creosote bush but extends eastward into southern Utah and northern Arizona.

SUMMARY

On the basis of field sampling, climatic data, and soil examination, the basin sagebrush association of Clements is divided into two zones: sagebrush and shadscale. Each is a vegetation zone with a matrix community determined by climate. The matrices of the two zones are compared by analysis of quantitative samples of their dominant strata.

The shadscale zone is characterized by a much drier climate than the sagebrush zone and lies between the sagebrush and creosote bush zones. The zonal soils under shadscale vegetation are gray desert soils while those of the sagebrush zone are usually darker, often brownish. These gray desert soils may or may not possess a degree of salinity in the subsoil. Embedded in the matrix of the shadscale vegetation are edaphic communities which are characteristic of intrazonal or azonal soils.

The shadscale desert is a natural area which if its boundaries are arbitrarily set can be considered to be a distinct vegetation zone.

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TABLE I.—Climatic data

Stations in Shadscale Zone in Western Nevada and Eastern California

Station	mean annual precipitation in inches	mean January temperature ° F.	mean July temperature ° F.
Fallon, Nev.	4.98″	29.8°	73.1°
Lahontan, Nev.	4.54″	31.7°	78.2°
Fernley, Nev.	5.29″	34.1°	73.7°
Yerington, Nev.	4.61″	30.3°	70.5°
Schurz, Nev.	5.68″	31.3°	73.4°
Thorne, Nev.	3.08″	34.3°	77.3°
Lovelock, Nev.	4.79″	29.2°	73.0°
Hot Springs, Nev.	3.37″		
Fort Churchill, Nev.	5.31″		
Mina Nev.	3.45″	32.4°	78.0°
Independence, Calif.	4.49″	39.0°	78.3°
Average	4.51″	33.6°	75.1°

TABLE II.—Climatic data

Stations in Sagebrush Zone in Western and Northern Nevada

Station	mean annual precipitation in inches	mean January temperature ° F.	mean July temperature ° F.
Minden, Nev.	8.73″	32.2°	69.3°
Carson City, Nev.	9.29″	32.4°	68.6°
Reno, Nev.	7.73″	32.5°	71.0°
Elko, Nev.	9.46″	24.4°	69.8°
Wells, Nev.	9.36″	24.8°	69.9°
Winnemucca, Nev.	8.20″	28.0°	71.9°
Average	8.79″	29.05°	70.1°

TABLE III.—Total Soil Salinity Expressed as Conductance (K x 10⁵) of Soil Solution Filtrate for Shadscale and Sagebrush Stations

	Shadscale Stations							Sagebrush Stations		
Depth	1	2	3	4	5	6	7	1	2	3
0-2 cm.	13.2			92.6	16.4			22.8	28.1	21.9
10 cm.		20.6	9.1			34.9	12.3	24.2	11.6	13.4
30 cm.	12.0	24.0	8.6	18.7	48.3	68.0	98.3	11.6	10.1	21.8
50 cm.	11.3	19.0	11.8	46.8	89.6	287.3	246.4			
70 cm.		16.8	13.8			147.1	266.2	11.0	28.0	21.3
100 cm.	26.5	17.5		326.9	295.2	88.6				

TABLE IV.—Soil Characteristics at Representative Locations in the Shadscale Association

Location	soil type	% rock larger than 2 mm.	Analysis 2 mm. soil				pH
			% sand	% silt	% clay	% total "colloids"	
Shadscale Sta. 1							
0 - 2 cm.	sand	18.0	83.1	13.6	3.3	4.9	7.8
30 cm.	sand	7.0	85.1	9.6	5.3	7.9	7.9
50 cm.	sand	4.4	90.7	6.0	3.3	5.3	8.0
100 cm.	sand	12.4	80.5	14.4	5.1	9.2	8.9
Shadscale Sta. 4							
0 - 2 cm.	sand	12.5	83.7	13.0	3.3	7.3	9.4
30 cm.	sandy loam	10.0	64.7	21.0	14.3	18.3	8.9
50 cm.	sandy loam	2.9	58.7	34.0	7.3	11.3	9.4
100 cm.	silt loam	0	17.1	79.0	3.9	3.9	8.5
Shadscale Sta. 5							
0 - 2 cm.	sand	24.9	82.1	15.0	2.9	4.9	7.7
30 cm.	sandy clay loam	17.6	61.4	17.6	20.9	25.6	8.9
50 cm.	sandy loam	0	71.4	18.6	9.9	12.5	9.0
100 cm.	clay loam	3.9	49.8	25.6	24.6	28.2	8.9

TABLE V.—Shadscale Zone Station Numbers, Locations, and Elevations

Station Number	Location	Elevation (feet)
1	Desert Mountains, 7 miles N of Schurz, Nev., 39° 04′ N., 118° 47′ W.	4850
2	Virginia Mountains, 13 miles S of Fernley, Nev., 39° 27′ N., 119° 13′ W.	4550
3	4 miles NE of Hazen, Nev., 39° 37′ N., 119° 01′ W.	4150
4	9 miles E of Fernley, Nev., 39° 35′ N., 119° 06′ W.	4150
5	15.6 miles S of Fallon, Nev., 39° 14′ N., 118° 46′ W.	4050
6	29 miles NE of Lovelock, Nev., 40° 33′ N., 118° 16′ W.	4600
7	11 miles E of Hawthorne, Nev., 38° 32′ N., 118° 26′ W.	4700
8	Ft. Churchill, Nev. 39° 18′ N., 119° 17′ W.	4250
9	10 miles NE of Fernley, Nev., 39° 42′ N., 119° 07′ W.	4150
10	16 miles SW of Locke's Ranch, Nev., 38° 29′ N., 116° 02′ W.	5825
11	12 miles S of Tonopah, Nev., 37° 55′ N., 117° 15′ W.	5125
12	Inyo Range, 14 miles SE of Keeler, Calif., 36° 21′ N., 117° 43′ W.	4650
13	2 miles south of Sodaville, Nev., 38° 19′ N., 118° 07′ W.	4700
14	Ralston Valley, 6 miles E of Tonopah, Nev., 38° 05′ N., 117° 07′ W.	5500
15	Hot Creek Valley, 1 mile S of Warm Springs, Nev., 38° 11′ N., 116° 22′ W.	5600
16	N end of Pahrock Valley, Nev., 37° 36′ N., 115° 03′ W.	5000
17	2.5 miles E of Crystal Springs, Nev., 37° 33′ N., 115° 11′ W.	4200
18	17 miles W of Indian Springs, Nev., 36° 36′ N., 115° 58′ W.	3850
19	Specter Range, 20 miles E of Lathrop Wells, Nev., 36° 35′ N., 116° 04′ W.	3250
20	Funeral Mountains, 12 miles SW of Beatty, Nev., 36° 48′ N., 116° 55′ W.	4000
21	Dante's View, Black Mountains, Calif., 36° 14′ N., 116° 43′ W.	5220
22	Panamint Mountains, 13 miles SW of Stovepipe Wells, Calif., 36° 28′ N., 117° 17′ W.	4000
23	Towne's Pass, Panamint Mountains, Calif., 36° 25′ N., 117° 16′ W.	5000
24	7 miles NW of Bishop, Calif., 37° 24′ N., 118° 32′ W.	4300
25	S of Bartlett, Calif., 36° 27′ N., 118° 02′ W.	3800
26	5 miles E of Bigpine, Calif., 37° 13′ N., 118° 14′ W.	4500
27	3 miles E of Lida, Nev., 37° 27′ N., 117° 27′ W.	5600
28	17 miles S of Goldfield, Nev., 37° 28′ N., 117° 14′ W.	4800
29	8.5 miles W of Coaldale, Nev., 38° 01′ N., 118° 02′ W.	4700
30	7 miles S of Benton Station, Calif., 37° 43′ N., 118° 26′ W.	4800
31	Desert Mountains, 18.5 miles S of Fallon, Nev., 39° 14′ N., 118° 45′ W.	4300
32	5 miles N of Schurz, Nev., 39° 02′ N., 118° 48′ W.	4400
33	3.5 miles N of Wabuska, Nev., 39° 11′ N., 119° 13′ W.	4700
34	3 miles W of Sand Springs, Nev., 39° 19′ N., 118° 27′ W.	4050
35	4 miles SW of Pyramid Lake, Nev., 39° 53′ N., 119° 36′ W.	4250

TABLE VI.—Presence of woody plants at 35 widely distributed stations in the shadscale zone

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	%P
Atriplex confertifolia	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	97
Artemisia spinescens	×	×	×		×	×		×	×	×	×	×	×	×	×	×				×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	83
Sarcobatus baileyi	×	×	×	×	×		×	×	×	×	×		×	×								×	×	×				×			×	×	×	×	×	51
Ephedra nevadensis		×					×	×		×				×	×	×	×	×				×	×	×		×	×			×	×					49
Eurotia lanata	×	×		×			×	×												×			×	×		×					×	×		×	34
Lycium cooperi	×		×		×		×				×		×				×									×			×		×	×			34
Grayia spinosa	×									×				×	×	×	×			×		×		×										×	31
Glossopetalon spinescens												×					×	×			×			×			×	×							20
Tetradymia glabrata										×			×	×			×										×	×			×				20
Atriplex canescens							×						×	×		×										×			×						17
Dalea polyadenia			×				×	×					×				×											×							17
Lycium andersonii																×	×		×			×	×		×										17
Hymenoclea fasciculata													×				×									×	×				×				14
Tetradymia spinosa									×															×		×	×			×					14
Kochia americana		×					×					×	×													×	×								11
Franseria dumosa												×						×							×										9
Opuntia bigelovii															×												×			×					9
Opuntia pulchella			×					×																			×			×			×		9
Yucca brevifolia												×															×	×							9
Acamptopappus shockleyi							×																						×						6
Artemisia tridentata																×																		×	6
Dalea fremontii var. saundersii																										×				×					6
Encelia frutescens																										×				×					6
Ephedra funerea																				×	×														6
Lycium sp.																				×	×														6
Opuntia erinacea?								×																									×		6
Sarcobatus vermiculatus									×	×																									6
Chrysothamnus sp.										×																									3
Echinocactus polycephalus																			×																3
Eriogonum fasciculatum var. polifolium																										×									3
Eriogonum umbellatum																											×								3
Lepidium fremontii												×																							3
Yucca baccata																×																			3
Yucca mohavensis																		×																	3

TABLE VII.—Quantitative composition of the shrubby stratum of the shadscale association at twelve widely distributed stations. (D = density (number of plants) per 10 square meters, C = percentage coverage of total area, PC = percentage of total shrubby cover, × = present but not on plots.)

Species		1	2	3	4	5	6	7	8	9	10	11	12
Atriplex confertifolia	D	5.0	10.6	2.1	4.6	8.2	14.7	9.0	2.8	1.9	8.8	7.0	3.8
	C	.70	2.65	1.12	3.32	2.24	8.75	3.65	1.52	1.20	4.45	4.0	2.1
	PC	11.1	42.4	18.8	43.5	18.9	98.3	63.5	15.2	23.45	69.0	79.2	51.9
Artemisia spinescens	D	16.7	18.0	2.2		15.3	.3		9.7	.8	15.4	6.4	.3
	C	2.85	2.45	.76		2.72	.15		3.08	.12	1.9	1.0	.15
	PC	45.2	39.2	12.7		22.9	1.7		30.7	2.3	29.5	19.8	3.7
Sarcobatus baileyi	D	3.0	.6	3.5	2.6	5.1		.1	3.3	1.5	×	×	
	C	2.45	.70	3.24	4.32	6.88		.05	5.36	3.48			
	PC	38.9	11.2	54.4	56.5	58.0		.9	53.5	68.0			
Lycium cooperi	D	1.2		2.2		.1		5.1				.1	
	C	.15		.72		.02		1.60				.05	
	PC	2.4		12.1		.2		27.8				1.0	
Eurotia lanata	D	.4	.1		×				.1	.9			
	C	.10	.05						.02	.20			
	PC	1.6	.8						.2	3.9			
Grayia spinosa	D	.2									×		
	C	.05											
	PC	.8											
Ephedra nevadensis	D		.7					.4	.1		.1		
	C		.35					.35	.04		.05		
	PC		5.6					6.1	.4		.75		
Kochia americana	D		.2					.4					1.8
	C		.05					.10					.45
	PC		.8					1.7					11.1
Dalea polyadenia	D			.10				×	×				
	C			.12									
	PC			2.0									
Sarcobatus vermiculatus	D									.2	×		
	C									.12			
	PC									2.3			
Chrysothamnus sp.	D										.2		
	C										.05		
	PC										.75		
Franseria dumosa	D												2.4
	C												.95

Yucca mohavensis

TABLE VII (*Continued*)

Species		1	2	3	4	5	6	7	8	9	10	11	12
	PC												23.5
Glossopetalon spinescens	D												.3
	C												.35
	PC												8.6
Lepidium fremontii ..	D												.5
	C												.05
	PC												1.2
Opuntia pulchella ..				×					×				
Opuntia erinacea ?									×				
Atriplex canescens								×					
Tetradymia glabrata ..											×		
Acamptopappus shockleyi..								×					
Tetradymia spinosa										×			
Yucca brevifolia													×
Total density per 10 sq. m.		26.5	30.2	10.1	7.2	28.7	15.0	15.0	16.0	5.3	24.5	13.5	9.1
Total % coverage ..		6.30	6.25	5.96	7.64	11.86	8.90	5.75	10.02	5.12	6.45	5.05	4.05

Average total density = 16.8
Average total % cover = 6.95

TABLE VIII.—Quantitative composition of the shrubby stratum of the sagebrush association at four representative stations (D = density (number of plants) per 10 square meters, C = percentage coverage of total area, PC = percentage of total shrubby cover, × = present but not on plots)

Species		1	4	5	6
Artemisia tridentata	D	3.9	8.5	11.5	12.0
	C	8.9	16.6	18.6	13.4
	PC	60.5	73.1	86.4	91.5
Chrysothamnus nauseosus	D	.3		.1	
	C	.7		.2	
	PC	4.8		.9	
Tetradymia glabrata	D	1.2	.1	1.5	
	C	3.1	.2	2.6	
	PC	21.1	.9	12.1	
Purshia tridentata	D	.1	.8	.3	
	C	1.2	1.9	.1	
	PC	8.2	8.4	.45	
Ephedra viridis	D	1.2		.1	
	C	.8		.02	
	PC	5.4		.15	
Ribes velutinum	D		1.3		
	C		3.7		
	PC		16.3		
Eriogonum microthecum	D		.5		
	C		.3		
	PC		1.3		
Chrysothamnus sp.	D				2.6
	C				1.05
	PC				7.2
Gilia pungens	D				.7
	C				.2
	PC				1.3
Total density per 10 sq. m		6.7	11.2	13.5	15.3
Total % coverage		14.7	22.7	21.52	14.65

Average total density = 11.7
Average total % coverage = 18.39

Wolffia papulifera in Florida

Don L. Jacobs

Department of Botany, University of Georgia, Athens

Prior to this report *Wolffia papulifera* Thompson has apparently been known only from Missouri. It was first discovered in 1895 by B. F. Bush in the vicinity of Kennett, near the Arkansas border, in the southeastern corner of the state. In 1897 it was collected by C. H. Thompson near Columbia in central Missouri and described under its present name in his revision of the *North American Lemnaceae* (1898). Both of these early collections were in sterile condition. Flowering was first reported by Saeger (1929) from his observations of this phenomenon in a pond near Columbia during the summers of 1927 and 1928. His paper includes an excellent photograph of the material and records the occurrence of flowering specimens of *Lemna minor* L. and *Spirodela polyrhiza* (L.) Schleiden in association with the *Wolffia*.

Wolffia papulifera is readily distinguished from other Wolffias by the presence of a single conspicuous papilla which rises as a low, broad, conical mound from the center of the upper surface of the elliptical frond. It is about equal in size to the other North American members of the genus, *Wolffia columbiana* Karst. and *Wolffia punctata* Griseb., averaging nearly one millimeter in length.

The present Florida specimens were obtained from collections of class demonstration materials made by Dr. William M. Carlton of this department in O'Leno State Park, Columbia County, in north central Florida, 8 miles north of High Springs. The habitat was a ditch between a swamp and the embankment of U. S. Highway 41. *Wolffia papulifera* was associated with *Wolffia columbiana* and *Lemna perpusilla* Torr. but according to Dr. Carlton there was little other vegetation in the ditch. The water was dark brown.

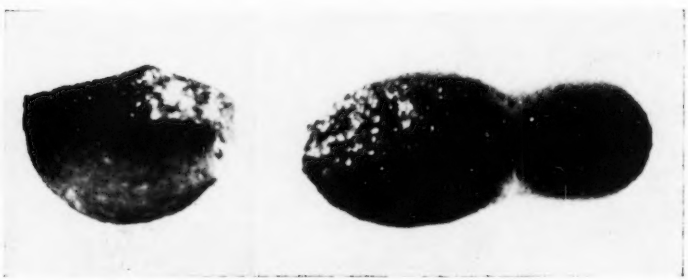

Fig. 1.—*Wolffia papulifera* ×35. Left—side view; right—top view.

Collections were made at two different times. The first one, September 20, 1948, contained very few plants of *Wolffia papulifera* so, while these were all sterile, it is possible that flowering material was present at the time. This collection included abundant flowers of *Lemna perpusilla* and *Wolffia columbiana* as well as numerous viable seeds of the former but none of the latter. The second collection (*Carlton*, December 24, 1948; Univ. of Georgia Herb., no. 31,611) contained a larger proportion (about one-fourth of the plants present) of *Wolffia papulifera* than the previous collection. Both species of *Wolffia* were sterile in this sample but *Lemna perpusilla* was still flowering sparsely.

The pond is located in a limestone area but no pH or other water analysis data are available as yet.

It is hardly conceivable that this duckweed has as disrupted a range as is indicated by the present records. It should, therefore, be searched for in suitable waters from Georgia to eastern Texas and Missouri. It will probably be found associated with other duckweeds and in waters that are not below pH 6.0. Muenscher (1944) refers to the distribution of this species as being "infrequent in the central states" but since he cites no specimens and omits the range map I presume that he refers only to the Missouri collections. Small's *Manual of the Southeastern Flora* (1933) includes only *Wolffia columbiana* and *Wolffia punctata*.

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New and Little Known Species of Caddis Flies

D. G. Denning
University of Wyoming, Laramie

Collections of Trichoptera recently studied by the writer have contained several new and interesting species, eight of which are described in this paper. In addition some interesting distributional data and descriptions of some poorly known species are included. Grateful acknowledgment is made to Dr. C. P. Alexander and J. F. Hanson of the University of Massachusetts, Dr. Edward S. Ross of the California Academy of Sciences, and Mr. V. D. Roth of Oregon State College for furnishing me the majority of the material discussed in this paper. Unless indicated otherwise types of the new species are in the writer's collection at the University of Wyoming.

Agapetus bifidus n. sp.

This species can readily be separated from the other described species by the bifid structure at the apex of the claspers which is easily discernible from either the dorsal or ventral view.

Male.—Length 5 mm. Body, head and base of legs dark brown, remainder of legs luteous, wings light brown. General structure typical of genus, including the lateral bulbous structure of the fifth sternite and the prominent thumb-like projection of the sixth sternite, fig. 1B.

Genitalia as in fig. 1. Ninth segment annular, dorsum only slightly narrowed. Tenth tergite consists of a pair of lightly sclerotized plates, when seen from the lateral aspect the ventral margin is curved dorsad to form a broadly rounded corner, apex with a darkly sclerotized acute spine, fig. 1; when seen from the dorsal aspect, fig. 1A, apices divergent, the small acute apical spine directed caudo-laterad, membranous sheath between lateral plates. Cerci from dorsal view, fig. 1A, narrowed toward base; from lateral aspect, fig. 1, somewhat trapezoidal in shape, apex truncate, ventral margin slightly sinuate; structure bears only a few scattered setae. Claspers about one and one-half times length of tenth tergite, tapering gradually from a wide base to a bluntly rounded apex; when seen from dorsal or ventral aspect, fig. 1, a short darkly sclerotized bidentate structure is projected mesad from the apex, no other processes are present on the mesal margin or mesal surface. Aedeagus tubular and unmodified, narrowed apically, originates in the seventh segment.

Holotype, male.—Oak Creek, Corvallis, Oregon, May 29, 1934, (Eldon Ball). Type deposited in the Entomology Department of the Oregon State College.

Agapetus occidentis n. sp.

This species can easily be separated from other described members of the

genus on the basis of the clasper which, when seen from the ventral aspect, has an acute darkened apex curved sharply mesad.

Male.—Length 4.5 mm. Body, head, antennae and base of legs brown, remainder of legs and wings ochraceous. Sternite of fifth segment with usual ovate organ, sixth sternum bearing a short blunt mesal process, fig. 2B.

Genitalia as in fig. 2. Claspers relatively short and wide, dorsal margin arcuate, apex blunt; viewed ventrally, fig. 2A, base wide, gradually narrowed apically, mesal margin edentate, apex acute, sharply curved mesad, tip dark brown in color; apex of one clasper bifid. Tenth tergite consists of two semimembranous plates, separated 3/5 of length and connected basally by a membranous sheath, each lateral lobe narrow, apically acute, apices bifarious; from lateral aspect ventral margin quite heavily sclerotized, curved gradually dorsad, apex short, acute. Cerci wide at base, only slightly narrowed apically, truncate at apex, bearing several long setae. Aedeagus a simple tubular unmodified structure.

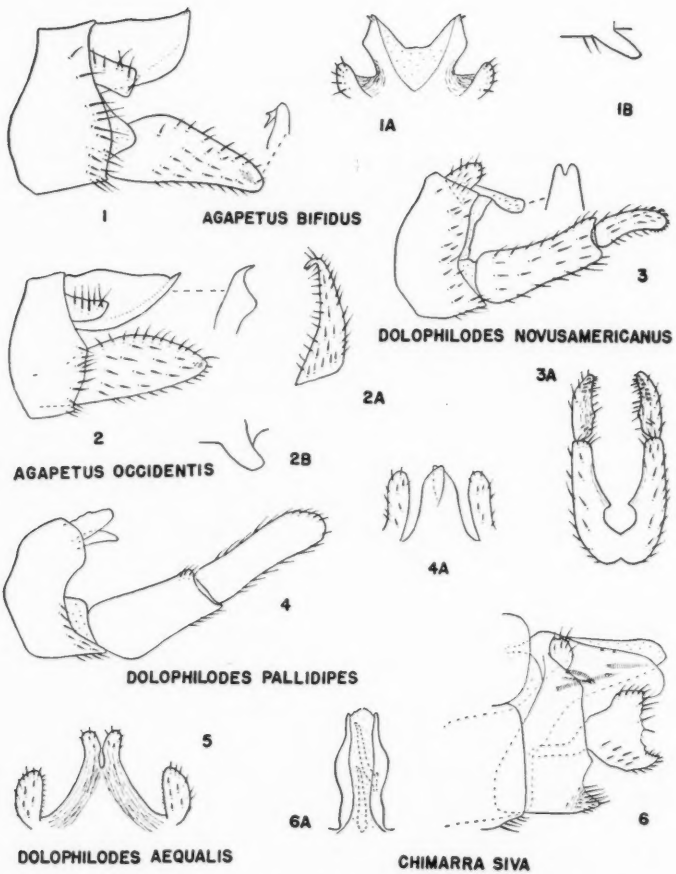
Holotype, male.—Adair, Oregon: May 9, 1941, (Jean Duspiva).

Adair is located in Benton County, about 11 miles north of Corvallis. Type deposited in the Entomology Department of Oregon State College, Corvallis, Ore.

Dolophilodes novusamericanus (Ling).—This species was described by Ling from a single male collected in Marin County, California, which is along the Pacific coast. Recently Dr. George Knowlton of the Utah Agricultural College, Logan, Utah sent the writer a male of the species collected at Coyle, Washington, September 16, 1940, by F. C. Harmston. This locality, a few miles west of Seattle, constitutes a very interesting record and would seem to indicate that eventually the species will be found throughout the western coast of the United States. Since the male genitalia of this species has not been published the holotype was kindly loaned to the writer by Dr. Edward S. Ross of the California Academy of Sciences, San Francisco, California and a drawing of the diagnostic characters, fig. 3, was prepared from it.

Dolophilodes novusamericanus can readily be separated from other members of the genus by the wide ovate cercus and the narrow curved apical segment of the clasper. Sternite of eighth segment bears a cluster of short acute spines. Ninth segment with sternite projected caudad beyond remainder. Tenth tergite from lateral aspect rather long, apex obtuse; from dorsal view apex slightly emarginate. Cercus short and ovate, base wide. Clasper with basal segment long, laterally compressed; apical segment narrowed, practically same width throughout, apical portion curved ventrad; apex blunt; apical margin bearing short scale-like setae. When seen from ventral aspect, fig. 3A, space at junction of claspers appears cordate; mesal margin bearing a thick brush of flattened setae; apical segment concave, short scale-like setae easily discernible along margin. Aedeagus consists of a dark brown narrowed acuminate rod located in the eighth and ninth segments.

The following additional distributional data are available: California, Gumboot Lake, near Shasta Mt., 6500 feet elevation, August 13, 1948, (C. P.



Figs. 1-6.—1. *Agapetus bifidus,* lateral aspect; 1A, tenth tergite and claspers, dorsal aspect; 1B, mesal process of sixth sternite; 2. *Agapetus occidentis,* lateral aspect; 2A, clasper, ventral aspect; 2B, mesal process of sixth sternite; 3. *Dolophilodes novusamericanus,* lateral aspect; 3A, claspers, ventral aspect; 4. *Dolophilodes pallidipes,* lateral aspect; 4A, tenth tergite and claspers, dorsal aspect; 5. *Dolophilodes aequalis,* dorsal aspect of tenth tergite and claspers; 6. *Chimarra siva,* lateral aspect; 6A, tenth tergite and aedeagus, dorsal aspect.

Alexander), and Store Gulch, Siskiyou National Forest, Illinois River, Oregon, 1190 feet elevation, August 8, 1948, (C. P. Alexander).

Dolophilodes pallidipes (Banks).—This species, except for several genitalic differences, is very similar to *aequalis* (Banks). The latter species is very variable in size and color, those collected early in the season are large and colored gray to black, those collected later are very similar to *pallidipes* in size and the light brown color. Recently Mr. Nathan Banks kindly sent the writer a paratype from which the genitalia of *pallidipes*, fig. 4, is drawn. *Dolophilodes pallidipes* is distinguishable from *aequalis* on the basis of differences in the ninth segment, the claspers and especially the cerci and tenth tergite. Viewed dorsally the cercus of *pallidipes*, fig. 4A, rather long and slender, tenth tergite apically divided into two overlapping flaps, the apex sub-acute and extending caudad only slightly beyond cerci; in *aequalis*, fig. 5, cerci somewhat orbicular from dorsal aspect, tenth tergite apically divided into two slender blunt divergent processes which reach caudad a considerable distance beyond the cerci. In *pallidipes* a dark colored long, slender, acuminate rod apically bent laterad is plainly discernible from dorsal aspect. The description and drawing of the male genitalia of *pallidipes* is based on a specimen collected at St. Regis Pass, Montana, July 27, (A. J. Melander), M. C. Z. paratype 22666. Also recorded from Mt. Cokely, Vancouver Island, B. C., August 10, 1948, (Richard Guppy).

Chimarra siva n. sp.

This is the second species in the genus recorded from the Rocky Mountain region of the United States. It bears greatest resemblance to *angustipennis* Banks from which it can be separated on the basis of the very large base of the aedeagus, the darkly sclerotized acuminate rods in the aedeagus and the shape of the ninth segment.

Male.—Length 6 mm. General color of wings light brown, body and head dark brown, legs and spurs a trifle lighter in color than wings. Genitalia as in fig. 6. Ninth segment with ventral portion wide and bearing an acute triangular mesal projection, dorsum reduced to a narrow lightly sclerotized band fused to the tenth tergite. Tenth tergite composed of a pair of lightly sclerotized somewhat quadrangular lateral plates, apex obtuse; from dorsal aspect, fig. 6A, lateral plates appear sinuate in outline. Cerci, at base of tenth tergite, orbiculate, dorsal margin irregular, several long fine setae present. Claspers, viewed laterally, with base attenuated, apex greatly expanded, ventral corner triangular and extended caudad beyond remainder, apical margin serrate; convex outer surface with only a few scattered setae, apical margin bearing several rather stout setae, concave inner surface with but a few scattered setae; from caudal aspect apical, dorsal or ventral margin bear no projection. Aedeagus with very wide base which is suddenly constricted to a tubular structure with apex membranous and projected dorsad between the lateral plates of the tenth tergite, internally, fig. 6A, two acuminate rods plainly discernible, cephalad to these are a pair of small curved rods.

Holotype, male.—Avalanche Creek, Broadwater County, 40 miles south Cascade Glen, Montana, July, 1928.

Parapsyche spinata n. sp.

This species is closely related to *almota* Ross from which it can be distinguished by the shorter and wider ninth segment, by the narrower declivous humps of the ninth segment, by a prominent pair of spines at the base of the tenth tergite, by the shorter much wider claspers and several other genitalic differences. The adult is light yellow in color while *almota* is much larger and dark brown.

Male.—Length 10.5 mm. Head, body and base of legs light brown, remainder of legs, antennae and wings light yellow; anterior portion of front wing faintly irrorate with blackish setae, setation sparse over entire wing.

Genitalia as in fig. 7. Ninth segment with sternum narrow, dorsally widened, declivous humps constricted at base. Tenth tergite divided into a pair of cylindrical dorsally curved arms projecting caudad only a short distance beyond digitate process of clasper (much shorter than in *almota*); at base of lateral arms is a prominent acute dorsad directed spine; apex of arms with a scattering of acute spicules when seen under high magnification, fig. 7; from dorsal aspect arms gradually convergent, basal spines easily discernible, fig. 7A; a pair of heavily sclerotized arms connect base of tergite to dorsal sheath of aedeagus (in *almota* along the lateral aspect). Clasper with long slender digitate process, main body somewhat quadrate when seen from lateral aspect, dorsal margin arcuate. Aedeagus with base wide, arising from dorsum of structure is a short flattened structure barely discernible (in *almota* the similar process is very prominent and rounded), apex with a large hook curved ventrad.

Holotype male.—House Rock Forest Camp, Willamette National Forest, Oregon, August 3, 1948, (C. P. Alexander).

Parapsyche almota Ross.—Known to occur from one locality each in British Columbia, Washington and Oregon it is herein recorded from Beaver, Utah, June 26, 1942, (C. P. Alexander) and Merritt, Washington, Wenatchee River, June 9, 1948, (D. G. Denning).

Homoplectra shasta n. sp.

This, the fourth species to be described in the genus, can easily be distinguished from *alseae* not only on the basis of its much smaller size but also in many differences of male genitalia, especially in the armature of the aedeagus.

Male.—Length 5.5 mm. Head, body and base of legs blackish, femora fuscous, remainder of legs brown, spurs a trifle lighter in color. Wings brown, rather densely covered with short dark hairs. Venation as that described for genus. As in *alseae* a pair of arcuate shaped flat filaments extend caudad across the entire fifth sternite.

Genitalia as in fig. 8. Ninth sternum quite heavily sclerotized, somewhat

triangular in shape. Dorsal horn-like processes of tenth tergite do not reach level of tergite. Clasper long, slender, distally expanded, appearing acute from lateral aspect; from caudal view apices convergent and obtuse. Aedeagus with basal half tubular, base very wide with an acute large prong extending caudad into the ninth sternum. Armature of aedeagus as follows, fig. 8A: (1) dorsal prong flat, acute, furcate to near base, ventral surface bearing a small triangular process; (2) a pair of lightly sclerotized, long slender filaments distally acute and flat; (3) a pair of short stout heavily sclerotized processes, apex acute and curved dorsad; (4) aedeagus proper tubular, long and lightly sclerotized; (5) a trough-like process into which the aedeagus proper fits, distal third widely expanded and bifid, apex acute and upturned.

Holotype, male.—Gumboot Lake, near Shasta Mt., California, 6500 feet elevation, August 13, 1948, (C. P. Alexander).

Limnephilus paonius n. sp.

This species, which was presented to the writer by Dr. George Knowlton, bears some resembance to *occidentis* Banks, but can easily be distinguished from described species by the series of spines at the apex of the lateral arm of the aedeagus, the notched margin of the cercus and several other details of the male genitalia.

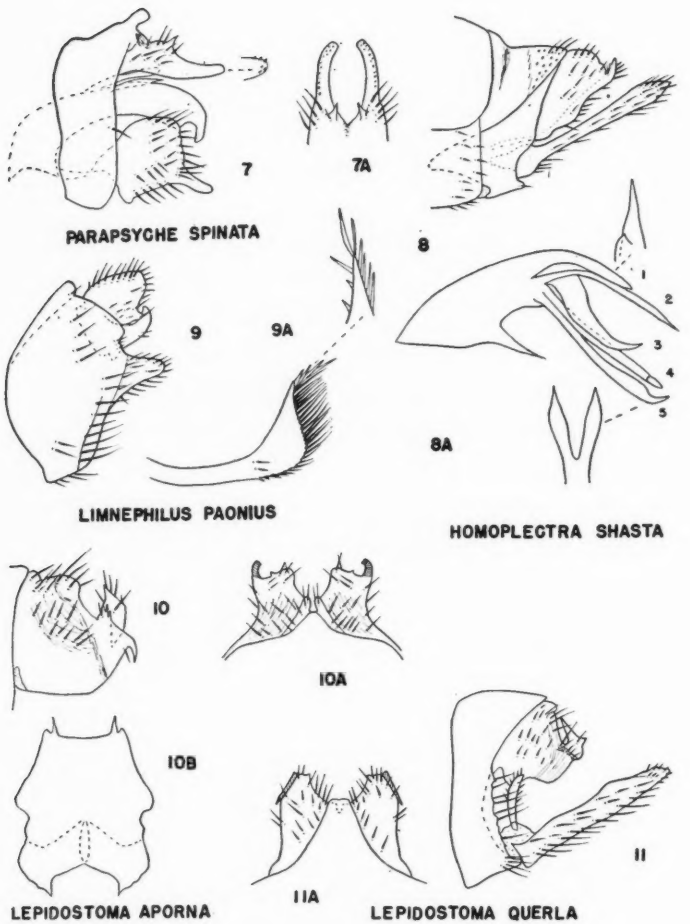
Male.—Length 12 mm. Wings tawny brown, marked with a series of brown lines along the veins, anal area with an irrorate appearance. Macrochaetae of head and thorax long, stout, light brown in color. Anterior femur with a long narrow inner row of minute black spines, tibia with fifteen black spines scattered irregularly over entire tibia together with a single long yellow spur, basitarsus one-third longer than succeeding segment.

Genitalia as in fig. 9. Eighth tergite without any modifications. Ninth segment reduced dorsally to a narrow collar. Tenth tergite with lobes thin, plate-like, ventral margin arcuate, apex subacute and curved dorsad above dorsal margin; seen from dorsal aspect apices gradually divergent. Cerci semiovate, distal margin distinctly emarginate, ventral angle produced slightly mesad as a point. Clasper projected directly caudad only a short distance beyond either cercus or tenth tergite, apex obtuse, setation sparse. Aedeagus with cylindrical mesal tube relatively short and stout, distal portion slightly more slender; lateral arms fig. 9A, short and stout, apically enlarged to a thin plate-like lobe, apex acuminate and bearing a series of six stout acute spines curved dorso-caudad, mesal margin bearing a long and two short flattened spines near apex, best seen from dorsal aspect, fig. 9A, fringe along distal margin fine, yellowish.

Holoype, male.—Lat. 64° 24′ 30″ N., Long. 21° 34′ W., Iceland, June 25, 1943, (T. O. Thatcher).

Lepidostoma aporna n. sp.

This species is a member of the *pluvialis* group and except for differences in the tenth tergite bears closest resemblance to the next species, *Lepidostoma*



Figs. 7-11.—7. *Parapsyche spinata,* lateral aspect; 7A, dorsal aspect of tenth tergite; 8. *Homoplectra shasta,* lateral aspect; 8A, lateral aspect of aedeagus; 9. *Limnephilus paonius,* lateral aspect; 9A, apex of lateral arm of aedeagus; 10. *Lepidostoma aporna,* lateral aspect; 10A, tenth tergite dorsal aspect; 10B, spermatheca; 11. *Lepidostoma querla,* lateral aspect; 11A, tenth tergite, dorsal aspect.

querla. It can readily be separated from that and other species by the prominent ventrad directed spur of the apical margin of the tenth tergite.

Male.—Length 8 mm. Head, thorax, abdomen and coxae brownish, legs yellow. Basal segment of antennae equals dorsal width of head, mesal surface with black scales. Front wings light brown, costal cells reflexed, margined with dense black scales, dense brown scales elsewhere in pocket.

Genitalia as in fig. 10. Ninth segment annular, dorsum produced caudad slightly beyond remainder. Tenth tergite from dorsal aspect, fig. 10A, separated on meson entire length; appearing as a pair of basal lobes, short, obtuse, bearing a scattering of setae, and a pair of large concave lobes, apically truncate and bearing the large ventrad directed spur at the latero-apical corner, although this spur is partially concealed from dorsal view. Seen from lateral view, fig. 10, apico-ventral corner broadly rounded, apical margin of ventral lobe produced into an acute, prominent, ventrad directed spur; directed dorsad from this spur arises a dorsad directed projection whose cephalad corner is produced into an acute point; basal lobe rotundate, bearing a scattering of yellowish setae. Clasper from lateral aspect long, narrow, bearing a slender finger-like basal projection; from ventral aspect basal portion wide, suddenly constricted distad, apex sub-truncate, near apex along mesal surface a small acute finger-like process; all except apex and extreme base clothed with long dense setae. Aedeagus long, tubular, apex submembranous; arising near base is a pair of tubular acuminate rods.

Female.—Length 8.5 mm. Very similar in general appearance to male except lacking reflexed portion of front wings and absence of black scales. Basal segment of antennae long, a trifle longer than in male, mesal surface with long brownish hair. Spermatheca as in fig. 10B.

Holotype, male.—Beaver, Utah, altitude 8000 feet, June 26, 1942, (C. P. Alexander).

Allotype, female.—Same data as for holotype.

Lepidostoma querla n. sp.

On the basis of the clasper this species is related to the *pluvialis* group differing from other described species in the shape of the tenth tergite. This species can easily be determined by the prominent dorsad directed spur along the lateral margin of the tenth tergite.

Male.—Length 7 mm. Head, thorax, abdomen, and coxae brownish, legs yellowish. Basal segment of antennae about as long as dorsal width of head, mesal surface bearing a dense brush of black scales. Maxillary palpi with third segment bearing a long dense brush of black scales. Front wings light brown, costal cells reflexed, along margin of reflexed portion the black scales are very dense, an abundance of brown scales with a scattering of black scales throughout remainder of pocket.

Genitalia as in fig. 11. Ninth segment annular, dorsum extended caudad as a blunt projection when seen from dorsal view, lateral margin bearing a few

stout yellowish setae. Tenth tergite divided into two lateral lobes, widely separated on meson, fig. 11A, apex subtruncate and bearing at corner the large dorsad directed spur. From lateral view, fig. 11, the apical margin is produced into an acute prominent dorsad directed spur which occupies most of the apical margin of the tergite, ventro-apical corner broadly rounded; a scattering of fairly long setae over most of tergite. Claspers narrow, long, basal process slender and finger-like when seen laterally, fig. 11; from ventral view basal portion wide, apical portion greatly constricted, apex sub-truncate and devoid of setae; mesal projection near apex small, acute. Aedeagus long, tubular, apex submembranous, arising from base is a pair of acuminate rods along dorsal surface.

Holotype, male.—Oak Creek Canyon, Arizona, June, 1942, (C. P. Alexander).

Dr. C. P. Alexander states that the locality is just south of Flagstaff, and that the collection was probably made at Banjo Bill Forest Camp at an altitude of 5180 feet.

Lepidostoma carolina (Banks).—This species was previously known only from North Carolina.

South Carolina: Aitken, October 4, 1943, (D. G. Denning), 1 male, 1 female.

Lepidostoma cascadensis Milne.—Previous records of this species are from British Columbia, Washington, California, Colorado, and Idaho. The following records extend the known range considerably.

Oregon: Bend, Tumalo Creek, 3610 feet altitude, August 14, 1948, (C. P. Alexander), 1 male. Washington: North Bend, King County, July 10, 1920, (E. P. VanDuzee), 1 male. Montana: Red Lodge, August 24, 1948, (R. E. Pfadt), 2 males, 1 female. Wyoming: Albany County, Snowy Range Mts., July 22, 1948, (D. G. Denning), many males and females.

Lepidostoma cantha Ross.—Previously known only from the type locality, Monterey County, California.

California: Berkeley, June 5, 1925, (H. H. Keifer), 2 males.

Lepidosoma frosti (Milne).—Previous records are from New Hampshire and Quebec.

Massachusetts: Amethyst Brook, Pelham, June 19, 1938, (J. F. Hanson), 1 male. Maine: Limerick Mills, May 31, 1940, (J. F. Hanson), 1 male.

Lepidostoma griseum (Banks).—This is a new southern record in the species known distribution.

North Carolina: Franklin, August 17, 1938, (R. H. Beamer), 1 male.

Lepidostoma jewetti Ross.—Until now this species was known from 1 male taken at Ellsworth, Washington.

California: Meadow Valley, Plumas County, 4-5,000 feet altitude, July 8, 1924, (E. C. Van Dyke), 1 male. This locality is in the northeastern part of

the state. British Columbia: Wellington, September 25, 1948, (Richard Guppy).

Lepidostoma knowltoni Ross.—Additional records from Utah are Hatch and Panguitch, June 16, July 14, 1948, (G. F. Knowlton), 5 males. Montana: Duck Creek, Gallatin County, July 9, 1948, (Ray Hays).

Lepidostoma latipennis (Banks).—An additional record in its known southern distribution is Macon, Georgia, May, 1944, (Rodney Dodge), 1 male, 1 female.

Lepidostoma ontario Ross.—This species was previously known only from Ontario and New Hampshire.

Maine: Cañon Brook, Mt. Desert Isle, June 23, 1935, (C. P. Alexander).

Lepidostoma ormea Ross.—This species was previously recorded only from Utah.

Colorado: Illinois River, south of Walden, August 10, 1947, (D. G. Denning), 1 male.

Lepidostoma podager (McL.).—Very little is known regarding the distribution of this species. The following records indicate that the species is present throughout the central portion of California and probably western Nevada.

California: Lake Tahoe, June 23, 1927, (E. H. Nast), 1 male; Marin County, May 4, 1924, 1 male; Mt. Diablo, April 18, 1935, (H. J. Rayner), 2 males, 6 females; Yosemite, altitude 3880-4000 feet, June 12, and 14, 1931, (E. O. Essig), 3 males, 1 female; Yosemite Valley, June 21 and 25, 1921, (E. C. Van Dyke), 4 males, 2 females; Yosemite Valley, July 5 and 6, 1927, (E. H. Nast), 2 males, 1 female.

The writer concurs with Ross (1946) that the male genitalia of *podager* is "almost exactly as illustrated for *quercina*." A series of thirteen male genitalia was recently studied and after comparison to a series of *quercina* males it was the opinion of the writer that when the slight variation in the individual genitalia is considered the two species are identified except for the sexual dimorphism exhibited in the male *podager* tibia, basitarsus and maxillary palpi. Female genitalia of *podager*, when the slight variations are considered, is also inseparable from a series of female genitalia of *quercina* studied. The true status of these two species may have to be determined from a study of the larvae, or of individuals where the two populations overlap, when such a condition is found.

Lepidostoma quercina Ross.—This species was previously known only from Oregon.

Idaho: Mica Creek, along Coeur d'Alene Lake, June 8, 1948, (D. G. Denning), 8 males, 6 females.

Lepidostoma prominens Banks.—This species was previously known only from Nova Scotia and Quebec.

New Hampshire: Mt. Washington, August 4, 1944, (J. F. Hanson), 2 males, 1 female; Tuckermans Ravine Trail, White Mts., July 29 and 31, 1944, (J. F. Hanson), 2 males, 2 females. Massachusetts: Amherst, June 30, 1941, light trap, 1 male.

Lepidstoma roafi (Milne).—The following records represent a considerable extension in the known eastern range of this species.

South Dakota: stream near Legion Lake, east of Custer, August 28, 1947, (D. G. Denning), 2 males, 2 females.

Lepidostoma veleda Denning.—The following represents additional records of this recently described species.

Wyoming: Laramie River, Woods Landing, July 15, 1948, (D. G. Denning); Little Laramie River, Albany County, July 14, 1948, (D. G. Denning), many males and females.

Colorado: Frying Pan River, Eagle County, August 1, 1948, 4 males.

Lepidostoma vernalis (Banks).—This species has previously been recorded from New York and North Carolina.

New Hampshire: Huntington Ravine and Tuckerman Ravine, White Mts., July 17, 1942, altitude 5000 feet, (Marion Smith), 2 males. Massachusetts: Whatley Glen, May 19, 1939, (J. F. Hanson), 1 male.

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Contributions to a Synopsis of the Hemiptera of Missouri, Pt. IV*

Hebridae, Mesoveliidae, Cimicidae, Anthocoridae, Cryptostemmatidae, Isometopidae, Meridae

Richard C. Froeschner

Museum of Science, Academy of Science of St. Louis, St. Louis, Missouri

As with previous sections, this paper is to be considered only as a basis on which later workers may build. Therefore, no claim is made for completeness, except only in-so-far as has been possible with the material available. Inclusion of "probable species" in the Miridae has been done with considerable reserve. Undoubtedly, quite a number of additional species will be found with more intensive collecting.

Since publication of the key to families in Part I it has become necessary to amend that key with a change and two additions. The family name Naeogeidae must be changed to Hebridae (*vide* Harris 1942) and two more families, the Cryptostemmatidae and Isometopidae, must be added. In the key these two families would run to Anthocoridae in couplet 25. The three may be separated as follows:

25a. (25). Beak 3-segmented 25b
Beak 4-segmented; membrane with at least one closed cell ..... Isometopidae

25b. (25a). Membrane well defined; head porrect ..... Anthocoridae
Membrane very poorly or not at all differentiated from the corium; head strongly declivent ..... Cryptostemmatidae

I am obliged to Dr. Leonard Haseman for permission to study the material in the collection of the University of Missouri; and to the following men for the privilege of reviewing specimens in their personal collections: Dr. E. P. Meiners and Messrs. H. E. Brown, W. S. Craig, J. A. Denning, W. R. Enns and H. I. Rainwater. To Dr. H. H. Knight of Iowa State College I am especially deeply indebted for the tremendous amount of time that he has given so freely in identifying material and helping me with many of the problems in the large and sometimes difficult family Miridae. He has also very kindly lent us specimens to be used in figuring groups not represented in our collection. To Dr. R. I. Sailer of the National Museum I am also grateful for the loan and identification of specimens.

The plates are the original work of my wife, Elsie Herbold Froeschner.

Records not my own are initialed to indicate the person responsible for them, as in the following list: A. G. Peterson, B. O. Brayton, C. H. Bowen, C. W. Wingo, E. H. Froeschner, E. P. Meiners, H. E. Brown, H. I. Rainwater, J. A. Denning, T. E. Birkett, W. S. Craig and W. W. Smith.

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* Parts I, II & III in this journal 26(1): 122-146, 1941; 27(3): 591-609, 1942; 31(3): 638-683, 1944.

Keys to the Missouri Genera and Species of Hebridae

1. Antennae 5-segmented (not counting small one between antennals II and III) ..... I. *Hebrus*
   Antennae 4-segmented ..... II. *Merragata*

I. HEBRUS Curtis

1. Apex of scutellum angled, not or very feebly emarginate 2
   Apex of scutellum distinctly notched or bifid 3

2. (1). Antennae uniformly pale brownish-yellow, III longer than either IV or V; length 2-2.3 mm. ..... 303. *concinnus* Uhl. (Fig. 89)*
   Antennal I yellow, II-V darker, III subequal to V, both longer than IV; length 1.8-2 mm. ..... 304. *consolidus* Uhl.*

3. (1). Head above with a deep, longitudinal groove which extends almost its entire length; length 2.1 mm. ..... 305. *buenoi* Drk. & Harr.
   Head above evenly convex or with only a vague suggestion of a median groove; length 2.2 mm. ..... 305½. *burmeisteri* Leth. & Serv.

II. MERRAGATA White

1. Color black with vertex, base of tylus and two areas on hind lobe of pronotum reddish-brown; membrane strongly marked with fuscous; length 1.6-2 mm. ..... 306. *hebroides* White
   Color reddish-brown, both above and beneath; macropterous forms with clavus and membrane entirely milky-white; brachypterous forms with hemelytra represented by small white pads which do not reach tergite II; length 1.4-1.6 mm. ..... 307. *brunnea* Drk.

Keys to Missouri Genus and Species of Mesoveliidae

1. Head prolonged and declivent beyond eyes; hemelytra in winged forms with clavus largely membranous and membrane veinless ..... I. *Mesovelia*

I. MESOVELIA Mulsant & Rey

1. Front and middle femora each with a row of spines on lower hind margin; beak reaching to base of hind coxae; length 3.1-4 mm. ..... 308. *mulsanti* White (Fig. 90)
   Front and middle femora not spined ventrally; beak reaching almost to apex of hind coxae, length 2.1-2.8 mm. ..... 309. *cryptophila* Hgfd.

Keys to Missouri Genera and Species of Cimicidae

1. Antennal III longer than IV; front margin of pronotum deeply, arcuately concave; pubescence of dorsum distinctly shorter than that of body margins ..... I. *Cimex*
   Antennal III and IV subequal; pronotum with front margin almost straight across, antero-lateral angles somewhat prolonged; pubescence of dorsum and margins long ..... II. *Oeciacus*

I. CIMEX Linnaeus

1. Length of hairs on pronotal margin shorter than the width of an eye; scutellum longer than the commissure of hemelytral pads; length 5-6 mm. ..... 310. *lectularius* Linn. (Fig. 91)
   Length of hairs on pronotal margin greater than the width of an eye 2

2. (1). Marginal hairs of abdomen shorter and much more densely placed than those of pronotal margin; length 3.8-4.3 mm. ..... 311. *pilosellus* (Horv.)
   Marginal hairs of abdomen subequal in length and density to those of pronotal margin; length 3.5-4 mm. ..... 311½. *adjunctus* Barb.

* = *H. sobrinus* Uhl.: see footnote page 155.

II. OECIACUS Stal

1. Pale reddish-brown, hemelytra, beak and legs dull yellow; antennal I not attaining apex of tylus; length 3.6-4.5 mm. ..... 312. *vicarius* Horv.

Keys to the Missouri Subfamilies, Genera and Species of Anthocoridae

1. Antennals III and IV linear, more slender than I and II and with numerous long hairs; front femora more or less swollen, not dentate ventrally—Subfamily Lyctocorinae 2
   Antennals III and IV short, fusiform, with very short hairs; front femora never swollen—Subfamily Anthocorinae 5
2. (1). Pronotum with sides distinctly entirely margined and reflexed; hemelytra, except membrane, thickly punctured throughout ..... I. *Lyctocoris*
   Pronotum with sides never more than partially margined, not reflexed but sometimes deflexed 3
3. (2). Pronotum and hemelytra with side margins ciliate; osteolar canal curved backward ..... II. *Lasiochilus*
   Pronotum and hemelytra not ciliate along side margins; osteolar canal curved forward 4
4. (3). Clavus impunctate; sides of pronotum not margined ..... III. *Xylocoris*
   Clavus with two or three rows of punctures; sides of pronotum margined anteriorly ..... IV. *Asthenidea*
5. (1). Pronotum with a distinct collar; membrane with four veins, the inner one sometimes very faint; corium not or only obsoletely punctate ..... V. *Anthocoris*
   Pronotum without a collar; membrane with three veins; antennal II not longer than interocular width ..... VI. *Orius*

I. LYCTOCORIS Hahn

1. Beak reaching middle coxae, segment I scarcely surpassing hind margin of eyes; membrane with but one distinct vein; length 3.5-3.8 mm. ..... 313. *campestris* (Fab.)
   Beak reaching hind coxae, segment I reaching base of head: membrane with four distinct veins; length 3.8-4.2 mm. ..... 314. *stalii* (Reut.) (Fig. 92)

II. LASIOCHILUS Reuter

1. Macropterous: clavus obsoletely or not punctate; pronotum and hemelytra with a fringe of short hairs; length 2.5-2.8 mm. ..... 315. *fusculus* Reut.

III. XYLOCORIS Dufour

1. Hemelytra uniformly light yellow, with at most tip of clavus and cuneus and outer margin of membrane fuscous; osteolar canal obtusely angulate at middle; length 2.8-3 mm. ..... 316. *galactinus* (Fieb.)

IV. ASTHENIDEA Reuter

1. Hemelytra yellowish-white, with outer half of cuneus black; femora piceous, paler at apex; length 2.2-2.5 mm. ..... 317. *temnostethoides* Reut.

V. ANTHOCORIS Fallen

1. Piceous black with outer half of clavus and basal half of corium yellowish-white; pronotal disk and apical part of scutellum finely and transversely rugose; length 3.5-3.7 mm. ..... 318. *musculus* (Say)

VI. ORIUS Wolff

1. Antennal I and femora wholly or in great part piceous; length 1.8-2 mm. ..... 319. *insidiosus* (Say) (Fig. 93)

Keys to Missouri Genera and Species of Isometopidae

1. Pronotum about four times as broad as long, its front margins bisinuate, the anterior angles remote from the eyes and not attaining their middle; antennal II unicolorous; cuneus nearly reaching apex of membrane .....I. *Teratodia*

Pronotum about four times as broad as long, its front margin deeply emarginate so that the anterior angles surpass the middle of the eyes; antennal II annulate medially with black; cuneus nearly reaching apex of membrane .....II. *Diphleps*

I. TERATODIA Bergroth

1. Pale brownish-yellow, apex of scutellum, dot on inner margin of cuneus and row of dots on apical half of costal margin fuscous or black; length 1.8-2 mm. .....320. *emoritura* Bergr. (Fig. 98)

II. DIPHLEPS Bergroth

1. Grayish-yellow, apex of tylus, two spots near inner margin of eyes, mesonotum in great part, apex of scutellum, several spots on costal margin and a dot on inner margin of cuneus fuscous or black; length 2 mm. .....321. *unica* Bergr.

Keys to Missouri Genus and Species of Cryptostemmatidae

1. Base of scutellum over half as wide as hind margin of pronotum; eyes not overlapping front angles of pronotum; antennal II at least three times as long as I—Subfamily Cryptostemmatinae .....I. *Ceratocombus*

I. CERATOCOMBUS Signoret

1. Antennal II surpassing apex of head by three-fourths its length; lateral margin of pronotum with two bristles; forewing with but one vein leaving apex of discal cell; head, pronotum, scutellum and basal half of clavus shining black, remainder of hemelytra yellowish-hyaline, the veins darkened; length 1.3 mm. .....322. *latipennis* Uhl. (Fig. 94)

Keys to Missouri Subfamilies, Tribes, Genera and Species of Miridae

1. Arolia present, erect and prominent, approximate at base between claws (Figs. c. d. e. f.) 8

Figs. c-j.—Tarsal claw characters used in the classification of the Miridae.

Arolia absent, or present but bristle-like in form (Figs. g. h. i. j.), sometimes difficult to distinguish from hairs on the tarsus 2

2. (1). Apical tarsal segment slender, not thicker than anteapical one 3
Apical tarsal segment swollen, always thicker than anteapical one; tibiae without spines—Subfamily Bryocorinae 27

3. (2). Pronotum not gibbosely convex anteriorly 4
Pronotum gibbosely convex anteriorly; constriction of collar visible only at sides from which an impressed line extends to behind the calli—Subfamily Clivineminae 32

4. (3). Pronotum without a subapical constriction to form a collar—Subfamily Phylinae 10
Pronotum with a subapical ring-like constriction forming a collar 5

5. (4). Tarsal claws thick, either sharply bent, broadly curved or more sharply bent and cleft near base (Figs. h. i. j.) 6

Tarsal claws simple and slender (Fig. g.); tibiae weakly spinose, long and tapering apically or else greatly shortened; in the latter case tarsal I is unusually long, the head transverse and the eyes strongly protruding—Subfamily Cylapinae 30

6. (5). Hemelytra strongly glassy-translucent; head horizontal but with part beyond eyes sharply vertical—Subfamily Hyaliodinae ..... XX. *Hyaliodes*
Hemelytra, except membrane never glassy-translucent nor hyaline 7

7. (6). Tarsal claws not toothed basally, pseudarolia prominent, with a pair of bristle-like arolia between them (Fig. j.)—Subfamily Dicyphinae 25
Tarsal claws toothed or cleft near base (Fig. i.), pseudarolia absent, bristle-like arolia present—Subfamily Deraeocorinae 33

8. (1). Arolia diverging apically (Figs. e. f.) 9
Arolia converging apically (Figs. c. d.); pronotum without a subapical ring-like constriction, i.e., without a collar—Subfamily Orthotylinae 36

9. (8). Pronotum without a subapical ring-like constriction; tarsal segment I much longer than and equal in thickness to II—Subfamily Mirinae 55
Pronotum with a subapical ring-like constriction forming a collar; tarsal I not longer than II, or if longer, then I is distinctly thicker than II—Subfamily Capsinae 60

10. (4). Pronotum not flattened apically; abdomen not constricted basally 11
Pronotum with a flattened collar apically, but without a constriction behind it; abdomen usually distinctly constricted basally—Tribe Hallodapini 23

11. (10). Prosternum convex, without raised margins; markings when present not as in other half of couplet—Tribe Phylini 12
Prosternum depressed on its middle, margins raised; cuneus pale with transverse black bar across middle, membrane dark brown or black with prominent white marginal spots—Tribe Oncotylini ..... XVI. *Macrotylus*

12. (11). Pubescence, when present, composed of a single type of fine, suberect or prostrate hairs 13
Pubescence composed of closely appressed, tomentose or scale-like hairs and interspersed with more erect pubescent hairs 18

13. (12). Antennal II not or but slightly wider than width of head across eyes; head (viewed laterally) with facial angle forming a right angle 14
Antennal II distinctly longer than width of head across eyes; head with facial angle less than a right angle 16

14. (13). Femora pale with conspicuous black spots ventrally ..... I. *Campylomma*
Femora pale to dark brown or black, without dark spots 15

15. (14). Hemelytra black with a transverse pale mark across middle of clavi ..... X. *Leucopoecila*
Hemelytra uniformly dark brown to black, without pale markings ..... II. *Chlamydatus*

16. (13). Tibiae pale, spines dark but without black spots at their bases 17
Tibiae in great part pale, spines with black spots at their bases, if these spots absent, then dorsum and tibial spines pale ..... III. *Plagiognathus*

17. (16). Antennal II distinctly thinner than I; I distinctly surpassing tip of tylus; color in no part red ..... IV. *Microphylellus*
Antennal II swollen, its apex at least as thick as I; color in part red ..... V. *Rhinocapsus*

18. (12). Antennal II incrassate, as thick or thicker than I (except in female of *Criocoris* where dorsum is entirely black and tylus is strongly produced causing apex of head to be very acute) 19
Antennal II more slender than I 21

19. (18). Head, viewed from above, transverse, not protruding in front of antennal bases ..... X. *Rhinacloa*

Head, from above, distinctly produced in front of antennal bases 20

20. (19). Tylus strongly produced, its apex acute ..... IX. *Criocoris*
Tylus not produced, its apex blunt ..... XII. *Atractotomus*

21. (18). Antennal II shorter than width of head across eyes ..... VII. *Lepidopsallus*
Antennal II longer than width of head across eyes 22

22. (21). Dorsum greenish-yellow, hemelytra with more or less conspicuous fuscous markings; pseudolaria attached only at base of claws, tips free and extending to middle of claw (Fig. j.) ..... VIII. *Reuteroscopus*
Dorsum not colored as above; pseudarolia minute, connate and not extending free for a space greater than base of attachment ..... VI. *Psallus*

23. (10). Antennal II strongly clavate, its thickness at apex more than twice that at base; beak reaching almost to hind coxae; hemelytra fully developed in both sexes ..... XIII. *Teleorhinus*
Antennal II linear or but slightly thickened at apex; beak not surpassing middle coxae; females brachypterous or wingless 24

24. (23). Antennal II linear; females wingless ..... XIV. *Coquillettia*
Antennal II slightly thickened at apex; females brachypterous ..... XV. *Orectoderus*

25. (7). Pronotum transversely sulcate just behind calli ..... XVIII. *Dicyphus*
Pronotum not transversely sulcate behind calli 26

26. (25). Eyes large, postocular space of head less than half the length of an eye ..... XVII. *Cyrtopeltis*
Eyes small, postocular space of head subequal to length of an eye ..... XIX. *Macrolophus*

27. (2). Pronotum with a distinct collar, its hind lobe but moderately convex, sparsely punctate ..... XXI. *Monalocoris*
Pronotum without a collar, its hind lobe convex, sometimes strongly so, densely punctate 28

28. (27). Scutellum with a triangular discal impression; antennal I but slightly more than half as long as width of vertex ..... XXIV. *Halticotoma*
Scutellum without a triangular discal impression 29

29. (28). Hind lobe of pronotum with a longitudinal median impression; embolium broadly flattened ..... XXIII. *Pycnoderes*
Hind lobe of pronotum without a longitudinal median impression; embolium linear, thickened ..... XXII. *Sixeonotus*

30. (5). Vertex with a longitudinal median impression, eyes projecting above dorsum of head; antennae longer than body—Tribe Cylapini ..... XXV. *Cylapus*
Vertex without a median impression; antennae not longer than body; calli enlarged and elevated, occupying anterior two-thirds of pronotum—Tribe Fulviini 31

31. (30). Tarsi 3-segmented; costal margins subparallel; side margins of pronotum not explanate ..... XXVI. *Fulvius*
Tarsi 2-segmented; costal margins strongly arcuate; side margins of pronotum explanate ..... XXVII. *Peritropis*

32. (3). Membrane distinctly pubescent; pronotal collar not produced above base of head ..... XXIX. *Bothynotus*
Membrane glabrous; collar of pronotum produced above base of head ..... XXVIII. *Clivinema*

33. (7). Antennal II broad and distinctly flattened ..... XXXIII. *Hesperophyllum*
Antennal II cylindrical 34

34. (33). Vertex distinctly transversely striate and longitudinally sulcate; hind tarsi with segment II shorter than either I or III ..... XXX. *Eustictus*
Vertex polished, scarcely or not at all striate nor sulcate; hind tarsus with segment II subequal in length to either I or III 35

35. (34). Head strongly produced, extending beyond apex of antennal I; embolium thin and broadly expanded, sides nearly parallel .....XXXII. *Eurychilopterella*
Head not so strongly produced, scarcely surpassing middle of antennal I; embolium neither thin nor broadly expanded .....XXXI. *Deraeocoris*

36. (8). Pronotum separated from propleura by a distinct suture; pronotal disk raised posteriorly and projecting above base of scutellum—Tribe Semiini .....XXXIV. *Semium*
Pronotal disk not separated from propleura by suture and not projecting above base of scutellum 37

37. (36). Robust, short oval or ovate; hind femora thickened, for jumping; vertex, from above, wider than long—Tribe Halticini 42
Elongate; hind femora not particularly thickened; vertex usually longer than broad 38

38. (37). Form not ant-like, abdomen not constricted at base 39
Form ant-like, abdomen constricted at base 41

39. (38). Antennal III distinctly more slender than II 40
Antennal III as thick as II—Tribe Ceratocapsini .....XLVII. *Ceratocapsus*

40. (39). Sides of pronotum distinctly carinate; front margin of pronotum usually set off by a transverse depression before calli; vertex wider than long—Tribe Lopidini 44
Sides of pronotum not carinate, or if so, transverse impression before calli absent; length of head usually as great or greater than width of vertex—Tribe Orthotylini 46

41. (38). Antennals II and III of equal thickness; hemelytra without silvery markings —Tribe Systellonotini 51
Antennal II distinctly thicker than III; hemelytra usually with silvery markings composed of scale-like hairs—Tribe Pilophorini 52

42. (37). Head without sharp basal margin; color not black .....XXXV. *Parthenicus*
Head with a well defined basal margin; color black 43

43. (42). Antennae as long or longer than body, II four or more times longer than I; length not over 3.5 mm. .....XXXVI. *Halticus*
Antennae scarcely as long as hemelytra, II little more than three times as long as I; length more than 3.6 mm. .....XXXVII. *Strongylocoris*

44. (40). Base of vertex with a transverse bristle-bearing ridge; pronotum and hemelytra with numerous erect black bristles .....XXXVIII. *Hadronema*
Base of vertex without a bristle-bearing ridge; dorsum without erect black bristles 45

45. (44). Gena with an oblique suture leading from base of antenna to below eye; color in large part red or orange .....XXXIX. *Lopidea*
Genal suture, if present, leading from base of antenna to the eye; color in no part red or orange .....XL. *Ilnacora*

46. (40). Antennal II thickened on apical half .....XLVI. *Heterocordylus*
Antennal II linear, not thickened apically 47

47. (46). Eyes rounded behind and set at or near middle of head, well removed from anterior margin of pronotum .....XLI. *Diaphnidia*
Eyes straight behind and set close to anterior margin of pronotum 48

48. (47). Antennal I with a longitudinal black line on either side, these connected beneath near apex .....XLII. *Reuteria*
Antennal I without longitudinal black lines 49

49. (48). Pronotum and corium bearing numerous erect bristles intermixed with scattered scale-like pubescence; venter pale .....XLIII. *Melanotrichus*
Pronotum and corium with simple pubescence only 50

50. (49). Vertex three times as wide as dorsal width of an eye ..... XLV. *Labopidea*
Vertex above twice the dorsal width of an eye ..... XLIV. *Orthotylus*

51. (41). Scutellum convex, not produced conically upward ..... XLVIII. *Sericophanes*
Scutellar disk produced conically upward ..... XLIX. *Cyrtopeltocoris*

52. (41). Antennal I at least as long as dorsal width of vertex plus one eye; vertex without a prominent transverse carina basally ..... L. *Pseudoxenetus*
Antennal I not longer than width of vertex; vertex with prominent, transverse basal carina which slightly overlaps front margin of pronotum 53

53. (52). Antennal II but slightly thickened toward apex; head across eyes as wide or wider than base of pronotum ..... LI. *Alepidia*
Antennal II distinctly thickened toward apex; head across eyes not as wide as base of pronotum 54

54. (53). Hemelytra not narrowed medially and without silvery cross-bands ..... LII. *Alepidiella*
Hemelytra narrowed medially and bearing silvery pubescent bands ..... LIII. *Pilophorus*

55. (9). Pronotum swollen at middle, as wide or wider than basal width; antennal I longer than width of vertex ..... LIV. *Mimoceps*
Pronotum not swollen at middle 56

56. (55). Eyes far removed from front margin of pronotum ..... LV. *Collaria*
Eyes nearly or quite in contact with front margin of pronotum 57

57. (56). Pronotum impunctate or nearly so 58
Pronotum deeply and coarsely punctured; antennal I thickly covered with very long pubescence ..... LIX. *Stenodema*

58. (57). Antennae thickly covered with long, erect, black hairs; body covered with fine, long, erect pubescence ..... LVI. *Miris*
Antennae clothed with very short pubescence; body nearly glabrous or with very short pubescence 59

59. (58). Head with front projecting much beyond bases of antennae; median sulcus of vertex deep, narrow; antennal I not as in other half of couplet ..... LVII. *Trigonotylus*
Front but slightly projecting beyond bases of antennae; vertex with a broad shallow basin; antennal I slender, curved, thickened at both ends but less so apically ..... LVIII. *Teratocoris*

60. (9). Form not ant-like, abdomen not constricted at base; lateral margins of hemelytra not decurved 61
Form ant-like, abdomen constricted basally; lateral margins of hemelytra decurved—Tribe Myrmecorini 82

61. (60). Pronotal collar convex, about as wide as calli; osteolar auricle poorly defined, its margins low—Tribe Resthenini 62
Pronotal collar convex, very narrow, never as wide as calli; osteolar auricle well defined, its margin elevated—Tribe Capsini 63

62. (61). Stricture of pronotal collar joining base of procoxal cleft; head, from side, oblique; gula long, oblique ..... LX. *Opistheuria*
Stricture of pronotal collar continuing ventrad anteriorly to procoxal cleft and so not running into it; gula short, scarcely apparent ..... LXI. *Platytylellus*

63. (61). Pronotum punctate, sometimes only very finely but usually distinctly so; calli usually prominent 64
Pronotum impunctate or with fine, aciculate punctures only 72

64. (63). Antennal II strongly clavate; vertex broad, foveate, distinctly striate each side near eye ..... LXII. *Capsus*
Antennal II linear or nearly so 65

65. (64). Pronotum punctate anteriorly to and between calli 66
Pronotum not punctate between and in front of calli 68

66. (65). Lateral margins of pronotum carinate, or at least with a calloused line; form ovoid 67
Lateral margins of pronotum not carinate; form elongate and subparallel ..... LXVI. *Xenoborus*

67. (66). Antennal I distinctly thicker than II, both segments black; body color black and red ..... LXIV. *Tropidosteptes*
Antennal I scarcely attaining thickness of II at apex; body color not black and red ..... LXV. *Neoborus*

68. (65). Antennals I and II thickly clothed with heavy black pubescence; large red species ..... LXIII. *Coccobaphes*
Antennal I sparsely clothed with pale pubescence 69

69. (68). Antennal II nearly as thick as I and never more than slightly attenuate at base 70
Antennal II distinctly thinner than I and noticeably thinner at base than at apex 71

70. (69). Antennal II twice the length of I; II very finely pubescent ..... LXVIII. *Neocapsus*
Antennal II three times as long as I; II thickly clothed with heavy black pubescence ..... LXVII. *Lygidea*

71. (69). Pronotum coarsely, or at least distinctly punctate; body integument heavily chitinized ..... LXIX. *Lygus*
Pronotum very finely punctate; body integument thinly chitinized, more fragile ..... LXX. *Neolygus*

72. (63). Antennal I thickened and clothed with numerous flattened hairs ..... LXXX. *Neurocolpus*
Antennal I without flattened hairs 73

73. (72). Pronotum with two opaque, rounded black spots in small, shallow cavities behind the calli; antennal I with long black hairs and setae ..... LXXVIII. *Paracalocoris*
Pronotum without black spots as above; antennal I with hairs not longer than the width of the segment 74

74. (73). Antennal II strongly swollen, fusiform ..... LXXIX. *Garganus*
Antennal II linear or only slightly thickened apically 75

75. (74). Hind femora distinctly surpassing apex of abdomen and flattened on basal half ..... LXXXI. *Phytocoris*
Hind femora not or scarcely surpassing apex of abdomen 76

76. (75). Hind tarsi with I much longer than III; two ill-defined stripes or spots on pronotum and a stripe on each hemelytron fuscous ..... LXXVII. *Stenotus*
Hind tarsi with I shorter than III; color not as above 77

77. (76). Upper surface pubescent, opaque or nearly so 78
Upper surface glabrous, highly polished 81

78. (77). Body above and below clothed with sericeous or tomentose pubescence; vertex with a pale spot either side near inner margin of eye ..... LXXIII. *Polymerus*
Body clothed above and below with simple pubescence; vertex without pale spots near eyes 79

79. (78). Head narrow, eyes well removed from anterior margin of pronotum; antennal IV equal in thickness to II at base ..... LXXVI. *Adelphocoris*
Head broad, eyes in contact with and overlapping front angles of pronotum 80

80. (79). Head declivent; vertex convex; width across head distinctly less than width of pronotum at base ..... LXXI. *Dichrooscytus*
Head subvertical; vertex flat; width of head across eyes almost as great as width of pronotum at base ..... LXXII. *Bolteria*

81. (77). Beak reaching to or surpassing midcoxae; antennal II almost glabrous ..... LXXV. *Horcias*

Beak but slightly surpassing front coxae; antennal II thickly clothed with black, bristle-like hairs ..... LXXIV. *Poecilocapsus*

82. (60). Scutellum convex, not produced conically upward ..... LXXXII. *Paraxenetus*
Scutellum produced conically upward ..... LXXXIII. *Barberiella*

I. CAMPYLOMMA Reuter

1. General color yellowish, with disk of cuneus and usually mesoscutum and base of scutellum marked with fuscous; tylus, apical half of antennal I and narrow base of II, and large spots on femora and tibiae black; length 2.5-2.9 mm. ..... 323. *verbasci* (Meyers)

II. CHLAMYDATUS Curtis

1. All femora, except for narrow apices, black; length 2-2.3 mm. ..... 324. *suavis* (Reut.)
Front and middle femora yellow, hind ones black with apices yellow; length 2.5 mm. ..... 325. *associatus* (Uhl.)

III. PLAGIOGNATHUS Fieber

1. Tibial spines pale, without black spots at their bases 2
Tibial spines dark with a black spot on the tibia at the base of each, these spots sometimes becoming evanescent toward apex of tibiae 4

2. (1). Antennal I with two black lines; femora with black lines near apex of dorsal and ventral margins; length 4.3 mm. ..... 326. *nigrolineatus* Kngt.
Antennal I unicolorous pale; hind femora with a double row of small black flecks on anterior face; length 3.3-3.5 mm. ..... 327. *sericeus* (Heid.)

4. (1). Antennal II fuscous to black, sometimes slightly paler medially, but always more black than light 5
Antennal II pale, sometimes with a narrow black ring at base 16

5. (4). Antennal II not over two-thirds basal width of pronotum 6
Antennal II three-fourths or more of basal width of pronotum 7

6. (5). Beak scarcely reaching base of mid coxae; antennal III distinctly shorter than width of head; dorsum black, extensively marked with yellow; length 3 mm. ..... 328. *gleditsiae* Kngt.
Beak surpassing hind margin of mid coxae; antennal III distinctly shorter than width of head; dorsum entirely black, including all of cuneus; length 3 mm. ..... 329. *nigronitens* Kngt.

7. (5). Combined length of antennals I and II less than basal width of pronotum; length 3.5-3.8 mm. ..... 330. *politus* Uhl.
a. Scutellum and all of dorsum except base of cuneus black ..... *p. politus* Uhl.
Most of scutellum, middle of pronotum, outer third of hemelytra and basal half of cuneus pale ..... *p. flaveolus* Kngt.
Combined length of antennals I and II at least as long as basal width of pronotum 8

8. (7). Antennal II not more than three-and-a-half times as long as width of vertex 9
Antennal II four or more times as long as width of vertex 14

9. (8). Width of head equal to or less than median length of pronotum 10
Width of head greater than median length of pronotum 13

10. (9). Cuneus with at least base pale 11
Cuneus uniformly black, sometimes with fracture brownish translucent 12

11. (10). Dorsum, except cuneus, uniformly black; legs pale, spotted with black; length 4-4.2 mm. ..... 331. *cuneatus* Kngt.
Dorsum not uniformly black or if nearly so the femora are nearly entirely black; length 4.4 mm. ..... 332. *obscurus* Uhl.
a. Cuneus uniformly pale; dorsum sometimes with large pale spots ..... *o. albocuneatus* Kngt.

b. (a). Scutellum with light patches laterally ..... *o. obscurus* Kngt.
Scutellum uniformly black ..... *o. fraternus* Kngt.

12. (10). Femora yellow, hind ones with a row of four or five black spots on antero-dorsal margin, also with a large spot on anterior face at apical fourth, but without lines; length 3.8-4 mm. ..... 333. *negundinis* Kngt.
a. Dorsum black, with only vertex pale ..... *n. negundinis* Kngt.
Dorsum black with embolium, outer half of corium, outer basal half of clavus and base of cuneus pale ..... *n. fulvotinctus* Kngt.

Femora black or yellow, if hind pair yellow then with a conspicuous black line postero-ventrally and a less distinct one above; length 4.2 mm. ..... 334. *annulatus* Uhl.
a. Hind femora pale with spots and line on postero-ventral margin and on top black ..... *a. annulatus* Uhl.
Hind femora black with apex only pale ..... *a. nigrofemoratus* Kngt.

13. (9). Black; head, scutellum, basal half of embolium and corium and base and outer margin of cuneus yellow, legs reddish-brown marked with black spots; length 3.9-4.5 mm. ..... 335. *flavoscutellatus* Kngt.

Reddish-brown, head and pronotum lighter; tylus, lora and mesosternum black; length 4.3-4.5 mm. ..... 336. *rosicola* Kngt.

14. (8). Antennal II not longer than base of pronotum; hind femora with a sub-apical group of fuscous spots or without spots; length 4.4-4.6 mm. ..... 337. *blatchleyi* Reut.
a. Pronotum and hemelytra uniformly light yellowish-brown or greenish ..... *b. blatchleyi* Reut.
Basal half of pronotum, apical half of corium and disk of clavus brown or black ..... *b. nubilis* Kngt.

Antennal II longer than basal width of pronotum 15

15. (14). Antennal I mostly pale; sternum black; length 4.4-4.7 mm. ..... 338. *albifacies* Kngt.

Antennae, except tip of I, entirely black; dorsum and venter pale translucent green; length 3.4-3.5 mm. ..... 339. *atricornis* Kngt.

16. (4). Antennal II less than basal width of the pronotum 17
Antennal II equal to or greater than basal width of pronotum 22

17. (16). Scutellum entirely black 18
Scutellum in large part pale 20

18. (17). Cuneus entirely pale; femora pale, spotted with black on anterior and posterior faces; length 3.7-3.9 mm. ..... 340. *tinctus* Kngt.
a. Cuneus and femora more or less reddish ..... *t. tinctus* Kngt.
Cuneus yellowish ..... *t. debilis* Blatch.

Cuneus almost wholly black 19

19. (18). Beak not surpassing mid coxae; cuneus uniformly black, scarcely translucent at base; length 3.7-3.8 mm. ..... 341 *punctatipes* Kngt.

Beak surpassing mid coxae; length 3.3-3.5 mm. ..... 342. *dispar* Kngt.
a. Cuneus with base narrowly yellowish translucent ..... *d. dispar* Kngt.
Cuneus uniformly black ..... *d. crataegi* Kngt.

20. (17). Scutellum with a broad, black median line; cuneus darkened apically; beak reaching posterior margin of hind coxae; length 3.5-3.9 mm. ..... 343. *similis* Kngt.

Scutellum wholly pale or darkened only at basal angles 21

21. (20). Antennal II at least three-fourths as long as basal width of pronotum; length 3.9-4.1 mm. ..... 344. *salicicola* Kngt.
a. Calli and two longitudinal stripes on corium black; cuneus black with margins pale ..... *s. salicicola* Kngt.
Dorsum uniformly pale or dark markings only faintly indicated ..... *s. depallens* Kngt.

Antennal II not over two-thirds as long as basal width of pronotum; length 3-3.2 mm. ..... 345. *delicatus* (Uhl.)

22. (16). Antennals I and II pale, the latter sometimes with a faint dusky area at base; dorsum pale, thickly marked with reddish or dusky brown spots; length 3 mm. ..... 346. *guttulosus* (Reut.)

Antennal I black with apex only pale 23

23. (22). Antennal II as long as basal width of pronotum and distinctly black at base; length 3.7-3.9 mm. ..... 347. *repletus* Kngt. (Fig. 100)

a. Cuneus uniformly pale ..... *r. repletus* Kngt.

Cuneus darkened apically ..... *r. apicatus* Kngt.

Antennal II longer than basal width of pronotum and entirely pale or only slightly darkened at base; length 4.2 mm. ..... 348. *albatus* (VanD.)

a. Scutellum and cuneus pale ..... *a. albatus* (VanD.)

Median line of scutellum and apical half of cuneus blackened ..... *a. vittiscutis* Kngt.

IV. MICROPHYLELLUS Reuter

1. Hemelytra uniformly blackish; antennals I and II chiefly pale, the latter shorter than basal width of pronotum; length 3.3-3.5 mm. ..... 349. *modestus* Reut.

Hemelytra with embolium, cuneus and basal half of corium pale; length 3.4-3.6 mm. ..... 350. *maculipennis* Kngt.

a. Antennal II and femora uniformly pale ..... *m. maculipennis* Kngt.

Antennal II dark brown to black ..... *m. fuscicornis* Kngt.

V. RHINOCAPSUS Uhler

1. Antennal II blackened apically, its basal third or more reddish-yellow; head, pronotum and scutellum and sternum in great part red; hemelytra and ventrals dark fuscous to black; length 3.5-4 mm. ..... 351. *vanduzeei* Uhl.

VI. PSALLUS Fieber

1. Antennal II pale with four or five distinct black spots; dorsum, except membrane thickly covered with pale fuscous spots; length 2.6-3.1 mm. ..... 352. *seriatus* (Reut.)

Antennals II pale or black, but without spots 2

2.(1). Antennal II yellowish, black only at base; length 3-3.2 mm. ..... 353. *amorphae* Kngt.

Antennal II black; femora dull yellow to fuscous, with one or two black spots above near apex; length 2.6-2.9 mm. ..... 354. *bakeri* (Berg.)

VII. LEPIDOPSALLUS Knight

1. Antennal I pale yellow 2

Antennal I very dark brown or black, II subequal to or shorter than III plus IV; length 3.2-3.5 mm. ..... 357. *rubidus* (Uhl.)

a. Color uniformly black; scale-like pubescence silvery-white ..... *r. atricolor* Kngt.

Color black with reddish areas; scale-like pubescence yellowish ..... *r. rubidus* (Uhl.)

2.(1). Antennal II six times as long as I; color reddish, occasionally blackish, veins of membrane red; length 2.7-2.8 mm. ..... 355. *miniatus* Kngt.

Antennal II four times as long as I; color brown to fuscous, never reddish; length 3 mm. ..... 356. *nyssae* Johns.

VIII. REUTEROSCOPUS Kirkaldy

1. Membrane uniformly fuscous except for clear spot at apex of cuneus and smaller spot just beyond; scutellum, clavus and bar across apical half of

corium fuscous to black; length 3-3.4 mm. ..... 358. *ornatus* (Reut.) (Fig. 102)

Membrane with many small, fuscous marks; scutellum and clavus yellowish, dotted with fuscous; length 3.3 mm. ..... 359. *sulphureus* (Reut.)

IX. CRIOCORIS Fieber

1. Head and body black, shining, with white scale-like pubescence intermixed with more erect pubescence; male with antennals I and II strongly thickened; length 2.7-3 mm. ..... 360. *saliens* (Reut.)

X. RHINACLOA Reuter

1. Fuscous to black, hemelytra paler at base, embolium with reddish spot at apex; membrane fuscous; legs brownish to fuscous, tibiae pale with spines and spots at bases of spines black; length 2.2 mm. ..... 361. *forticornis* Reut.

XI. LEUCOPOECILA Reuter

1. Black; prominent, irregular pale band across clavi and basal half of coria; base of cuneus and triangular spot just before it on corium pale; length 2-2.6 mm. ..... 362. *albofasciatus* Reut.

XII. ATRACTOTOMUS Fieber

1. Color black, tarsi pale, eyes, bases of hind tibiae, wing joint and vein at apex of areole in membrane reddish; scale-like pubescence silvery-white; antennal II about three times as long as I; length 2.6-2.8 mm. ..... 363. *crataegi* Kngt.

XIII. TELEORHINUS Uhler

1. Black, shining; legs pale orange; antennal I black, II yellowish with apical two-fifths black, III and IV fuscous, together slightly longer than II; length 7.3-7.6 mm. ..... 364. *tephrosicola* Kngt. (Fig. 99)

XIV. COQUILLETTIA Uhler

1. Sexually dimorphic: — male macropterous; dark orange-brown, basal half of corium transparent, apical half bright orange-brown with slender margin dark brown; basal third of cuneus white; length 6.4 mm. Female wingless, ant-like; head wider than pronotum; color brown with antennals III and IV and apex of II, tarsi and apices of tibiae fuscous to black; length 5.5 mm. ..... 365. *amoena* (Uhl.)

XV. ORECTODERUS Uhler

1. Sexually dimorphic: — male macropterous; black, shining, hemelytra brownish with basal half of corium and a large spot on apex of cuneus dull yellow; length 7.2-7.8 mm. Female macropterous or brachypterous; piceous to black, subopaque, corium and cuneus without pale markings; scutellum in part or wholly pale yellow; length 5.8-6 mm. ..... 366. *obliquus* Uhl.

XVI. MACROTYLUS Fieber

1. Dorsum chiefly green, ventral surface yellowish; femora yellowish each with a black stripe above; length 2-2.5 mm. ..... 367. *amoenus* Reut. (Fig. 101)

XVII. CYRTOPELTIS Reuter

1. Pale greenish-yellow, hemelytra with commissures, tips of embolium and cuneus and veins of membrane fuscous to black; femora with rows of small, black dots; length 4.5-4.7 mm. ..... 368. *varians* (Dist.)

XVIII. DICYPHUS Fieber

1. Head, pronotum and scutellum dark brown to black, pronotum with collar and sometimes space between the calli pale; length 3.8-4.5 mm. .....

.....369. *agilis* (Uhl.) (Fig. 95)
Head with vertex behind eyes pale; antennal II subequal to basal width of pronotum; length 3.5-3.8 mm. .....370. *vestitus* Uhl.

XIX. MACROLOPHUS Fieber

1. Antennal I equal to or slightly longer than width of head across eyes; antennal II distinctly longer than basal width of pronotum; length 4-4.2 mm. .....371. *tenuicornis* Blatch.
Antennal I shorter than width of head across eyes 2

2. (1). Postocular space nearly equal to lateral width of an eye; corium with but one row of fuscous spots on basal two-thirds and that bordering claval suture; length 3.6 mm. .....372. *brevicornis* Kngt.
Postocular space little more than half the lateral width of an eye; corium with three or four rows of fuscous spots on basal two-thirds; length 4-4.5 mm. .....373. *separatus* (Uhl.)

XX. HYALIODES Reuter

1. Antennal I four-fifths or more of the basal width of the pronotum; pronotum with collar, calli and areas laterad of calli dark brown or black, median line always pale; length 4.4-4.9 mm. .....374. *harti* Kngt. (Fig. 97)
Antennal I not more than three-fourths of basal width of pronotum; pronotum not colored as above 2

2. (1). Antennal I equal to or but slightly longer than width of head across eyes and about half the basal width of the pronotum; length 4 mm. .....375. *brevis* Kngt.
Antennal I distinctly longer than width of head across eyes and at least two-thirds the basal width of the pronotum; length 4.8 mm. .....376. *vitripennis* (Say)
a. Pronotum without median dark stripe .....*v. vitripennis* (Say)
Pronotum with a broad, median dark stripe extending from front margin to hind margin .....*v. discoidalis* Reut.

XXI. MONALOCORIS Dahlbom

1. Oval; pale brownish-yellow to dark brown, sparsely clothed with fine prostrate yellow hairs; membrane pale translucent with a dusky tinge, veins and cells darker; legs and beak yellow; length 2.3-2.7 mm. .....377. *filicis* (Linn.)

XXII. SIXEONOTUS Reuter

1. Femora wholly black 2
Femora not wholly black 3

2. (1). Dorsum clothed with conspicuous, semi-prostrate, yellowish hairs; length 2.8-3 mm. .....378. *tenebrosus* (Dist.)
Dorsum clothed with conspicuous, erect, white pubescence; length 2.9-3.2 mm. .....379. *unicolor* Kngt.

3. (1). Antennae and legs uniformly pale; membrane with basal half black; length 3.1-3.5 mm. .....380. *insignis* Reut.
Antennae black; hind femora and basal halves of tibiae fuscous; membrane pale, veins black; length 2.7-3 mm. .....381. *areolatus* Kngt.

XXIII. PYCNODERES Guerin

1. Legs black, tibiae paler apically; embolium with a large pale spot near base and a smaller one near apex; length 3.2-3.8 mm. .....382. *convexicollis* Blatch.
Legs pale, hind femora fuscous on apical half only; embolium with margins slightly arcuate and with a small pale spot near base and another near apex; length 2.8-2.9 mm. .....383. *medius* Kngt. (Fig. 103)

XXIV. HALTICOTOMA Reuter

1. Head, pronotum, base of scutellum, sterna and legs dull red or reddish-brown; hemelytra blue-black; membrane dusky, veins brown; ventrals reddish, piceous along sides; length 3-3.5 mm. .....384. *valida* Reut. (Fig. 104)

XXV. CYLAPUS Say

1. Brownish-gray with lower front of head, spot behind each apical angle and basal half of median carina of pronotum, a spot at tip and each side of apex of scutellum, an oblique submarginal line near middle of corium, apex of embolium and narrow inner margin of cuneus pale yellow or white; length 5.5-6.5 mm. .....385. *tenuicornis* Say (Fig. 96)

XXVI. FULVIUS Stal

1. Antennal II uniformly pale yellow; apex of scutellum pale; length 3.2-3.4 mm. .....386. *brunneus* (Prov.)
Antennal II with apical third or less pale; scutellum uniformly brown; length 4-4.5 mm. .....387. *imbecilis* (Say) (Fig. 105)

XXVII. PERITROPIS Uhler

1. Corium and clavus without narrow pale spots; coxae pale; length 2.7-3 mm. .....388. *saldaeformis* Uhl.
Corium and clavus with numerous scattered pale spots; coxae brown; length 3-3.2 mm. .....389. *husseyi* Kngt.

XXVIII. CLIVINEMA Reuter

1. Membrane whitish, not or only indistinctly infuscate on apical half; pronotum neither distinctly sulcate nor notched on median line; scutellum evenly convex with a short, median, basal impression .....390. *villosa* Reut.

XXIX. BOTHYNOTUS Fieber

1. Black, head red, tylus black; legs dark brown, tibiae slightly paler; antennal II one-and-one-half times as long as width of head; length 4-5.1 mm. .....391. *modestus* (Wirt.) (Fig. 107)

XXX. EUSTICTUS Reuter

1. Long fine hairs on basal half of hind tibiae distinctly longer than true spines; pronotum uniformly brown; legs reddish, tibiae without paler bands; length 8-11 mm. .....392. *filicornis* (Wlk.)
Minute hairs on basal half of hind tibiae shorter than true spines 2

2. (1). Pronotum black with collar and very narrow lateral margins pale; width of male vertex twice as great as thickness of antennal I; length 5.5-6 mm. .....393. *necopinus* Kngt.
Pronotum with wide median line black, broad lateral areas pale and punctured with black; width of male vertex only slightly greater than thickness of antennal I; length 6.9-7.4 mm. .....394. *salicicola* Kngt.

XXXI. DERAEOCORIS Fieber

1. Scutellum punctate; pronotum distinctly margined; antennal I surpassing tip of tylus by less than half its length 2
Scutellum impunctate 5

2. (1). Dorsum bright red, clavus, a pair of large spots on coria and on pronotum black; length 4.5-5 mm. .....395. *histrio* (Reut.)
Dorsum not black and red as above 3

3. (2). Cuneus not marked with red; membrane clear hyaline with a small round fuscous spot each side on apical half; length 3.5-3.9 mm. .....396. *nebulosus* (Uhl.)
Cuneus red or stained with red 4

4.(3). Antennal II as long or longer than pronotum; membrane fuscous at apex;

cuneus red; calli and scutellum in great part fuscous black; length 4-5 mm. .....397. *poecilus* (McA.) (Fig. 106)

Antennal II shorter than pronotum; membrane with two fuscous spots on apical half and sometimes a cloud between these; length 4.5-4.8 mm. ....398. *ornatus* Kngt.

5. (1). Tarsal claws not cleft; dorsum glabrous; form broad, width half as great as length; length 4.5-5 mm. .....399. *manitou* VanD.

a. Pronotum mostly pale, blackish on basal half and sides; scutellum with black spot either side of median pale line, these usually confluent at base .....*m. manitou* VanD.

Pronotum black, narrowly margined with pale; scutellum black, basal angle and apex only pale .....*m. intermedius* Kngt.

Tarsal claws deeply cleft near base 6

6. (5). Dorsum practically glabrous, at most sparsely and finely pubescent; hind tibiae with a row of spines or heavily chitinized hairs on anterior face 7

Dorsum heavily pubescent or hairy, at least on pronotum; hind tibiae not spinose on anterior face; calli black, cuneus not paler basally; length 7.4-7.9 mm. .....400. *sayi* (Reut.)

a. Scutellum pale or red ..... b

Scutellum black with never more than apex of middle line pale ..... e

b. Lateral margins of pronotum black or only narrowly pale at anterior angles c

Lateral margins of pronotum broadly pale or reddish ..... d

c. Front of head pale to reddish .....*s. sayi* (Reut.)

Front of head distinctly blackish .....*s. frontalis* Kngt.

d. Embolium black like corium .....*s. marginatus* Kngt.

Embolium pale and cuneus more-or-less translucent .....*s. costalis* Kngt.

e. Femora black, with pale annulus near apices .....*s. unicolor* Kngt.

Femora pale on basal half, with broad black annulus at apical third .....*s. femoralis* Kngt.

7. (6). Tibiae banded 8

Tibiae uniformly pale or yellowish; hind femora with but one subapical dark band 9

8. (7). Beak slightly surpassing hind margins of posterior coxae; membrane with apical half evenly but slightly infuscated; femora pale with two distinct black bands near apices; length 6.4-7 mm. .....401. *grandis* (Uhl.)

Beak not surpassing middle coxae; femora banded apically; no broad dark stripes behind pronotal calli; length 5.8-6.1 mm. .....402. *aphidiphagus* Kngt.

9. (7). At least pronotum and scutellum uniformly dark brown to black, usually entire upper surface so; length 5.3 mm. .....403. *davisi* Kngt.

Pronotum and scutellum not uniformly dark brown to black, these with at least the median line pale; length 5.5-5.8 mm. .....404. *quercicola* Kngt.

a. Dorsum darkened to such an extent that the three fuscous blotches on the hemelytra are not apparent .....*q. quercicola* Kngt.

Dorsum pallid brown with three dark spots, one each at apex, middle and base of each hemelytra .....*q. pallens* Kngt.

XXXII. EURYCHILOPTERELLA Reuter

1. Color uniform fuscous brown; length 4.7 mm. .....405. *brunneata* Kngt.

Color grayish-yellow with marks on basal half of pronotum, scutellum in great part, apical half or more of clavus, inner apical third of corium and cuneus in great part fuscous black; length 4.3-4.5 mm. .....406. *luridula* Reut.

XXXIII. HESPEROPHYLLUM Reuter & Poppius

1. Blackish-brown to black, shining; scutellum yellowish-white, its tip darker, membrane with a pale spot near tip of cuneus; edges of propleurae, beak

in part and apical halves of tibiae pale yellow; length 4 mm. .....
.....407. *heidemanni* Reut. & Popp.

XXXIV. SEMIUM Reuter

1. Velvety brown with head, antennals I and II and legs except tarsi reddish; scutellum, embolium, corium except apex, and cuneus except apex whitish; antennals I & II much stouter than III & IV; length 2.8-3.4 mm. .....
.....408. *hirtum* Reut. (Fig. 108)

XXXV. PARTHENICUS Reuter

1. General color and entire antennae pale 2
General color and antennal I black; length 3.3-3.5 mm. .....411. *nigrellus* Kngt.

2. (1). Dorsum and legs uniformly pale yellow or pinkish, without flecks or dots; length 2-2.2 mm. .....409. *taxodii* Kngt.
Dorsum more-or-less pale but usually sprinkled with numerous reddish dots; scutellum fuscous; cuneus tinged with red; length 2.7-3 mm. .....
.....410. *juniperi* (Heid.)

XXXVI. HALTICUS Hahn

1. Antennal II yellow with a narrow fuscous area apically; wings brachypterous or macropterous; length 2.5-3.5 mm. .....412. *intermedius* Uhl.
Antennal II with at least base and apex black, or entirely black; wings brachypterous or macropterous; length 1.5-2.2 mm. .....
.....413. *bracteatus* (Say) (Fig. 109)

XXXVII. STRONGYLOCORIS Blanchard

1. Dorsum glabrous or very nearly so; femora marked with black 2
Dorsum and body thickly clothed with erect pubescence 4

2 (1). Hind tibiae yellow, sometimes dusky on basal half; antennal I with apical half or more yellow, II yellow with narrow fuscous band at base and apex; length 4.1-4.3 mm. .....414. *breviatus* Kngt.
Hind tibiae with more area black than pale; antennal I nearly or quite all black, II all black or with a narrow yellowish band at middle 3

3. (2). Hind tibiae uniformly black; costal margin strongly arcuate; length 4.5-4.6 mm. .....415. *atritibialis* Kngt.
Hind tibiae paler apically; costal margins moderately arcuate; length 4.2-4.4 mm. .....416. *stygicus* (Say)

4. (1). Antennal II longer than width of head across eyes; tibiae and nearly all of antennal I yellow; length 4.3-4.6 mm. .....417. *hirtus* Kngt.
Antennal II shorter than width of head across eyes 5

5. (4). Tarsi with apical segment only black; basal half or more of hind tibiae fuscous to black; antennal II yellow with base and apex darkened; length 4.3 mm. .....418. *mohri* Kngt.
Tarsi entirely black; hind tibiae uniformly pale; antennal II wholly black; length 3.5 mm. .....419. *ambrosiae* Kngt.

XXXVIII. HADRONEMA Uhler

1. Antennal III shorter than II, both longer than width of head; propleurae and basal half or more of pronotum reddish; embolium, outer edge of corium and outer half of cuneus white; length 3.6 mm. .....420. *militare* Uhl.

XXXIX. LOPIDEA Uhler

1. Antennals I and II very stout, their bases of equal thickness 2
Antennals I and II slender, base of II not as thick as base of I 3

2. (1). Antennal II almost twice as long as width of head across eyes; length 5.4-6 mm. .....421. *instabilis* (Reut.)
Antennal II distinctly more than twice as long as width of head across eyes; length 6.9-7.1 mm. .....422. *reuteri* Kngt.

3. (1). Corium with both simple and sericeous pubescence 4
Corium with simple pubescence only 5

4. (3). Pronotum with numerous erect, stiff, black bristles; color orange and fuscous; length 6.3-6.8 mm. .....423. *robiniae* (Uhl.)
Pronotum without black bristles; color red and fuscous, costal margin sometimes narrowly pale; length 6.2-6.7 mm. .....424. *heidemanni* Kngt.

5. (3). Antennal II distinctly more than twice as long as width of head across eyes; length 6.5-6.8 mm. .....425. *staphyleae* Kngt.
Antennal II not more than twice as long as width of head across eyes 6

6. (5). Antennal II twice as long as width of head across eyes; length 6.3-6.5 mm. .....426. *confluenta* (Say)
Antennal II less than twice as long as width of head 7

7. (6). Pronotum, scutellum and hemelytra (except membrane) with numerous coarse, suberect, black bristles; length 6.1-6.5 mm. .....427. *teton* Kngt.
Pronotum and scutellum with few or no black bristles 8

8. (7). Outer half of corium with suberect black bristles; length 5.5-5.7 mm. .....428. *davisi* Kngt.
Outer half of corium without black bristles 9

9. (8). Size small, length 5 mm. or less 10
Size larger, length at least 5.5 mm. 11

10. (9). Corium with fuscous expanded laterally so as to cross over radius; length 4.6-5 mm. .....429. *incurva* Kngt.
Corium with fuscous not crossing radius; length 4.2-4.5 mm. ....430. *minor* Kngt.

11. (9). Juga polished yellow or cream; antennal II with black pubescence; length 5.7-6.2 mm. .....431. *salicis* Kngt.
Juga colored, red or orange 12

12. (11). Dorsal pubescence minute, closely appressed; embolium colored like outer half of corium; length 5.9-6.3 mm. .....432. *amorphae* Kngt.
Dorsal pubescence silky, suberect; embolium sometimes white or yellow 13

13. (12). Pronotum black with anterior and lateral margins red; length 5.9-6.2 mm. .....433. *lathyri* Kngt.
Pronotum, except sometimes calli, wholly red; length 5.6-5.7 mm. .....434. *media* (Say) (Fig. 110)

XL. ILNACORA Reuter

1. Length of antennal I greater than width of vertex 2
Length of antennal I less than width of vertex 3

2. (1). Hemelytra dark green, membrane black; length 5.4-6 mm. ....435. *malina* (Uhl.)
Hemelytra pale or light green; membrane pale; length 5.2-5.7 mm. .....436. *stalii* Reut.

3. (1). Front of head with a transverse black mark; antennal I pale with base and apex black; length 4.7-5 mm. .....437. *divisa* Reut.
Front of head without a black mark; antennal I pale with subapical black band; length 4.8 mm. .....438. *illini* Kngt.

XLI. DIAPHNIDIA Uhler

1. General color, including head and antennae, pellucid greenish-white; eyes and tips of tarsi fuscous; length 4.3 mm. .....439. *pellucida* Uhl.

XLII. REUTERIA Puton

1. Antennal I with inner and outer black lines complete, nearly parallel, joined apically on ventral side 2
Antennal I with inner black line indistinct on basal half, transverse apical portion forming J-shaped mark with outer line; length 4.9 mm. .....444. *platani* Kngt.

2. (1). Antennal II with basal half or more fuscous to black; length 4.3 mm. ..... 440. *fuscicornis* Kngt.
Antennal II with never more than basal fourth blackish 3

3. (2). Corium, clavus and upper surface of hind femora conspicuously marked with green blotches; length 3.8-4.2 mm. ..... 441. *irrorata* (Say)
Corium and femora without well-defined green blotches 4

4. (3). Blackish ring at the base of antennal II longer than width of I; length 4.3-4.4 mm. ..... 442. *querci* Kngt.
Blackish ring at base of antennal II scarcely longer than width of I; membrane with large areole not bordered by fuscous; length 4.3-4.8 mm. ..... 443. *bifurcata* Kngt.

XLIII. MELANOTRICHUS Reuter

1. Upper surface with black, scale-like pubescence; length 3.8-4.1 mm. ..... 445. *althaeae* (Huss.)
Upper surface without black scale-like pubescence 2

2. (1). Hemelytra and scutellum greenish; antennal II longer than basal width of pronotum; membrane dusky, veins and areoles green; length 4 mm. ..... 446. *flavosparsus* (Sahlb.)
Hemelytra and scutellum dusky; antennal II shorter than basal width of pronotum; length 3.9-4.5 mm. ..... 447. *catulus* (VanD.)

LXIV. ORTHOTYLUS Fieber

1. General color green, without dark markings on corium 2
Ground color pale testaceous to black, if greenish, corium marked with fuscous or black 11

2. (1). Smaller, length not over 4 mm. 3
Larger, length at least 4.5 mm. 7

3. (2). Pubescence fuscous; beak usually reaching but little beyond middle of mesosternum; length 3.7-3.8 mm. ..... 448. *chlorionis* (Say)
Pubescence pale; beak reaching to or surpassing posterior margin of mesosternum 4

4. (3). Antennal II shorter than three times width of vertex; length 3.6 mm. ..... 449. *robiniae* Johns.
Antennal II as long as or longer than three times width of vertex 5

5. (4). Antennal III three-fourths as long as II; hemelytra with soft, simple pubescence intermixed with a limited number of minute, golden, silky hairs; length 3.5 mm. ..... 450. *ulmi* Kngt.
Antennal III not more than two-thirds as long as II; hemelytra with stiff, simple pubescence only 6

6. (5). Antennal II longer than basal width of pronotum; hemelytra and veins in membrane deep green; length 3.3-3.4 mm. ..... 451. *taxodii* Kngt.
Antennal II not longer than basal width of pronotum; hemelytra and veins of membrane yellowish-green, veins often paler; length 3.9-4.1 mm. ..... 452. *ramus* Kngt.

7. (2). Tylus with small fuscous spot at base 8
Tylus not marked with fuscous at base 9

8. (7). Membrane never darker than pale fuscous; clavus never infuscate; length 4.6-4.8 mm. ..... 453. *viridis* VanD.
Membrane dark fuscous to black; clavus sometimes slightly fuscous; length 4.4-4.5 mm. ..... 460. *modestus immaculatus* VanD.

9. (7). Antennal II twice as long as width of head; antennal I fuscous; length 5.6 mm. ..... 454. *basicornis* Kngt.
Antennal II less than twice as long as width of head 10

10. (9). Beak reaching upon middle coxae; antennal I pale above; length 5.8-6.1 mm. ....455. *rossi* Kngt.
Beak reaching hind margin of mesosternum; antennal I uniformly black; length 6.7-7.3 mm. ....456. *notabilis* Kngt.

11. (1). Ground color green, apical half of clavus, spot on corium and broad spot or vitta behind each callus black; length 6.7-7 mm. ....456. *notabilis* Kngt.
Ground color not green, or if so length less than 6.5 mm. 12

12. (11). Pronotal disk in part and most of hemelytra orange; embolium and either side of commissure blackish; length 4.6-4.8 mm. ....457. *submarginatus* (Say)
Pronotal disk in no part orange; dark markings of hemelytra distinct; length not over 6 mm. 13

13. (12). Pronotum laterally and propleurae, except ventral margins, black; median portion of pronotal disk and most of scutellum pale; length 4.8-5.1 mm. ....458. *lateralis* VanD.
Prothorax not so colored 14

14. (13). Antennal II shorter than twice the width of the head 15
Antennal II twice as long as width of head; juga black; length 4.9-5.2 mm. ....459. *dorsalis* (Prov.)

15. (14). Legs entirely green or yellowish; dorsum never tinged with reddish-orange; length 4.4-4.5 mm. ....460. *modestus modestus* VanD.
Legs pale to greenish, hind femora fuscous on apical half; pale areas of dorsum tinged with reddish-orange; length 5.6-6 mm. ....461. *ornatus* VanD. (Fig. 111)

XLV. LABOPIDEA Uhler

1. Pubescence very short, recumbent, with a few erect fuscous hairs scattered over pronotum and mesoscutum; length 3.5 mm. ....462. *ainsliei* Kngt.
Pubescence prominent, dorsum clothed with erect pale hairs; anterior margin of pronotum and calli slightly arched, raised above flat central disk; length 4-4.1 mm. ....463. *allii* Kngt.

XLVI. HETEROCORDYLUS Fieber

1. Black, hind part of pronotum and much of hemelytra reddish; antennal I about as long as width of vertex, II three times as long as I, III and IV linear, narrower than II; length 5.7-6.5 mm. ....464. *malina* Reut.

XLVII. CERATOCAPSUS Reuter

1. Dorsum without appressed, silky tomentose or scale-like pubescence, usually with simple erect hairs 2
Dorsum with appressed silky tomentose or scale-like hairs in addition to the more erect pubescence or hairs 5

2. (1). Head and antennae chiefly reddish; dorsum uniformly yellowish 3
Head and antennae not distinctly reddish; dorsum more or less infuscate 4

3. (2). Antennae wholly red; length 4.3-4.4 mm. ....465. *rubricornis* Kngt.
Antennal I and base of II yellowish; length 4.3-4.5 mm. ....466. *lutescens* Reut.

4. (2). A distinct, broad, pale band across hemelytra just behind apex of scutellum; length 3-3.1 mm. ....467. *fasciatus* (Uhl.)
Hemelytra without a distinct pale crossband; head and pronotum not or scarcely darker than hemelytra which are dark brown, usually with basal half paler; length 4-4.4 mm. ....468. *modestus* (Uhl.) (Fig. 112)

5. (1). Dorsum dark brown with a broad, pale band across hemelytra just beyond apex of scutellum; length 3.4-3.6 mm. ....469. *pilosulus* Kngt.
Dorsum without a pale band across hemelytra 6

6. (5). Pronotum impunctate, sometimes finely alutaceous 7
Pronotum punctate, sometimes rather finely so 10

7. (6). Clavus with long, pilose hairs; antennal I not more than three-fourths as long as width of vertex; sexually dimorphic, female brachypterous; length 2.8-3.8 mm. ....470. *camelus* Kngt.
Clavus without long, pilose hairs; antennal III longer than width of vertex plus width of one eye 8

8. (7). Antennal II at least as long as basal width of pronotum; color almost black; length 4.5-4.6 mm. ....471. *nigellus* Kngt.
Antennal II shorter than basal width of pronotum 9

9. (8). Antennals III and IV subequal in length; length 3.1-3.2 mm. ....
....472. *taxodii* Kngt.
Antennal III distinctly longer than IV; length 3.4-3.6 mm. ....473. *vicinus* Kngt.

10. (6). Antennal III longer than width of vertex plus one eye 11
Antennal III equal to or shorter than width of vertex plus one eye 14

11. (10). Antennal III at least as long as width of head 12
Antennal III not as long as width of head 13

12. (11). Pronotum and scutellum shining black, in strong contrast to the yellowish-brown coria; cuneus reddish; membrane milky-white with apical two-thirds dark fuscous; length 3.4 mm. ....474. *apicalis* Kngt.
Not contrastingly colored, general hue dark brown with head lighter; female sometimes brachypterous; length 2.5-3.1 mm. ....475. *setosus* Reut.

13. (11). Pronotum with a fuscous spot behind each callus; scutellum and clavus with a few long, erect hairs; length 3.1-3.8 mm. ....476. *complicatus* Kngt.
Pronotum with calli and front of disk fuscous to black; scutellum and clavus with much suberect, yellowish pubescence, but without long pilose hairs; length 3.7-3.9 mm. ....477. *pumilus* (Uhl.)

14. (10). Antennal II longer than width of head plus the additional width of one eye; length 3.7-3.9 mm. ....478. *incisus* Kngt.
Antennal II shorter than width of head plus one eye 15

15. (14). Antennal II and III uniformly pale yellowish 16
Antennal III reddish-brown or darker 17

16. (15). Membrane uniformly pale, at most only slightly smoky; beak not reaching middle of hind coxae; antennal I with a basal red mark; length 2.9-3.2 mm. ....479. *quadrispiculus* Kngt.
Membrane and veins fuscous with a pale spot near apex of cuneus; beak reaching middle of hind coxae; antennal I without a basal mark; length 3 mm. ....480. *uniformis* Kngt.

17. (15). Dorsum densely clothed with erect pubescence; membrane uniformly fuscous; length 3.4-3.5 mm. ....481. *digitulus* Kngt.
Dorsum sparsely clothed with erect pubescence; membrane pale, fuscous on apical third only; length 3.6-3.7 mm. ....482. *fuscinus* Kngt.

XLVIII. SERICOPHANES Reuter

1. Sexually dimorphic: — male macropterous; head, pronotum, scutellum and undersurface dark chestnut brown to blackish; hemelytra velvety-brown with a round, creamy spot on clavus just behind the scutellum and two oblique silvery-gray bars on corium. Female brachypterous; ant-like; yellowish-brown, with round, creamy spot on clavus behind scutellum. Length 3.1-3.5 mm. ....483. *heidemanni* Popp.

XLIX. CYRTOPELTOCORIS Reuter

1. Male: medium to dark brown, moderately shining; hemelytra slightly constricted near middle, dark brown, clavus paler on basal half, crossed on apical half by a clear white band that reaches costal margins, corium with a large, white spot at base of cuneus. Female unknown. Length 3.6 mm. ....484. *illini* Kngt. (Fig. 114)

L. PSEUDOXENETUS Reuter

1. Pronotum and pro- and mesosternum dark brown or black; length 6.5 mm. .....485. *scutellatus* (Uhl.) (Fig. 113)
Pronotum and pro- and mesosternum orange-red; length 6.5 mm. .....486. *regalis* (Uhl.)

LI. ALEPIDIA Reuter

1. Hemelytra ferrugineous black, membrane pale fuscous; antennae and legs pale yellowish, femora sometimes darkened; abdomen with a patch of silvery scales on either side near base; length 4.2 mm. .....487. *gracilis* (Uhl.)

LII. ALEPIDIELLA Poppius

1. Blackish-brown, front of head brown; elytra brownish-yellow, tip of clavus and inner apical half of corium darker; outer apical angle of corium and outer margin and tip of cuneus blackish; membrane brownish-yellow, a darker spot at center; length 3.5 mm. .....488. *heidemanni* Popp.

LIII. PILOPHORUS Westwood

1. Hemelytra polished over entire width behind posterior silvery crossbar 2
Hemelytra polished only on outer half or less of area behind posterior crossbar 7

2. (1). Hemelytra with erect, short black bristles; antennal III black, nearly as thick as first segment; length 5-5.3 mm. .....489. *vanduzeei* Kngt.
Hemelytra clothed with fine, recumbent pubescence which may be black but is never erect and bristle-like 3

3. (2). Pronotum with silvery, silky, tomentose pubescence; antennal II nearly four times as long as width of vertex, III pale; length 5-5.3 mm. .....490. *strobicola* Kngt.
Pronotum without silvery, silky pubescence 4

4. (3). Length not more than 3.9 mm.; posterior silvery line interrupted on corium but not dislocated at claval suture..... 5
Length 4.8-5.5 mm.; posterior silvery line not interrupted on corium, but slightly dislocated at claval suture; antennal II gradually thickened toward apex .....494. *amoenus* Uhl.

5. (4). Antennal II abruptly and strongly clavate on apical third; length 3.5-3.7 mm. .....491. *laetus* VanD.
Antennal II gradually thickened from middle to apex 6

6. (5). Antennae III dark brown, IV pale; length 3.7-3.9 .....492. *taxodii* Kngt.
Antennal III pale with apex darkened, IV fuscous; length 3.5-3.7 mm. .....493. *juniperi* Kngt.

7. (1). Length of antennal II less than length of head plus pronotum; beak not reaching hind coxae; posterior silvery band of corium not forming a straight, transverse line with claval band; length 3.2-3.7 mm. .....495. *walshii* Uhl.
Length of antennal II equal to or slightly longer than length of head plus pronotum; hemelytral pubescence fine and recumbent and with no short, erect hairs intermixed; length 3.8-4 mm. .....496. *brunneus* Popp.

LIV. MIMOCEPS Uhler

1. Pronotum wider across hind margin than at middle; calli large, convex, occupying middle of disk; length 5-6 mm. .....497. *insignis* Uhl.

LV. COLLARIA Provancher

1. Pronotal disk brown to fuscous, a large conspicuous black spot present on either side of basal half of disk; length 6-7 mm. .....498. *oculata* (Reut.)
Pronotal disk black, black spots obscure; length 6-7 mm. ....499. *meilleurii* Prov.

LVI. MIRIS Fabricius

1. Antennae longer than body; general color greenish or orange-brown, with a pair of black lines running over pronotum and scutellum; hemelytra variously marked with fuscous; length 7.3-8.5 mm. ..... 500. *dolobratus* (Linn.) (Fig. 115)

LVII. TRIGONOTYLUS Fieber

1. Hind legs with tarsi and tips of tibiae black; length 5.5-6.2 mm. ..... 501. *tarsalis* (Reut.)
Hind legs not thusly marked with black 2
2. (1). Antennal I shorter than width of head across eyes; length 4.1-4.8 mm. ..... 502. *brevipes* Jakov.
Antennal I longer than width of head across eyes 3
3. (2). Antennae reddish throughout; pronotum with vague fuscous stripes; segment I of hind tarsus at least as long as II plus III; length 5.5-6 mm. ..... 503. *ruficornis* (Geoff.)
Antennae reddish only toward base or not at all; pronotum with distinct reddish-brown stripes; segment I of hind tarsus shorter than II plus III; length 4.5-5 mm. ..... 504. *pulcher* Reut. (Fig. 116)

LVIII. TERATOCORIS Fieber

1. Scutellum and clavus fuscous to black; length 4.8-5.6 mm. ....505. *discolor* Uhl.
Scutellum and clavus uniformly green; length 5.2-6 mm. ....506. *paludum* Sahlb.

LIX. STENODEMA Laporte

1. Hind femora armed beneath near apex with three spines; antennae dull yellow; length 7-7.5 mm. ..... 507. *trispinosum* Reut.
Hind femora unarmed; antennae in great part reddish; length 7-7.5 mm. .... 508. *vicinum* (Prov.)

LX. OPISTHEURIA Reuter

1. Antennae, front of head, membrane and hemelytra black, the latter with cuneus and broad outer margins orange-red; beak reaching middle coxae; length 7-7.5 mm. ..... 509. *clandestina* VanD.
a. Pronotum and ventral surface, except genital segments, orange-red .... *c. clandestina* VanD.
Pronotal disk largely black ..... b
b. Ventral surface, except genital segments, orange-red ..... *c. dorsalis* Kngt.
Ventral surface chiefly black ..... *c. ventralis* Kngt.

LXI. PLATYTYLELLUS Reuter

1. Antennal I shorter than width of vertex 2
Antennal I subequal to or longer than width of vertex 4
2. (1). Disk of pronotum without a median red stripe 3
Disk of pronotum with a median red stripe which reaches red scutellum; length 5-5.3 mm. ..... 512. *rubrovittatus* (Stal)
3. (2). Antennal III half as long as II; vertex wholly or in great part black; length 8 mm. ..... 510. *confraternus* (Uhl.)
Antennal III at least three-fourths as long as II; vertex entirely red; length 6-6.5 mm. ..... 511. *nigricollis* (Reut.)
4. (1). Pronotum yellow or orange-red, if marked with black this along the median line 5
Pronotum in part black but with the median line red 7
5. (4). Head nearly or quite entirely red; antennal II at least three times as long as I; length 9-11 mm. ..... 513. *fraternus* Kngt.
a. Hemelytra wholly black ..... *f. fraternus* Kngt.

Hemelytra broadly pale laterally; calli, median stripe of pronotum and scutellum black ..... *f. rubromarginatus* Kngt.

Head black 6

6. (5). Scutellum orange-yellow; tibial hairs short, their length less than the diameter of tibia; length 8.5-10 mm. ..... 514. *insitivus* (Say)

Scutellum black; tibial hairs longer, the length of some of them exceeding the diameter of the tibia; length 9.2-9.7 mm. ..... 515. *nigroscutellatus* Kngt.

7. (4). Costal margins of hemelytra broadly orange-red; pronotum more-or-less marked with black along either side of middle; length 7-7.5 mm. ..... 516. *circumcinctus* (Say) (Fig. 117)

Hemelytra wholly black; length of antennal I but slightly greater than width of vertex; head in large part red; length 6.7-7.5 mm. ..... 517. *insignis* (Say)

LXII. CAPSUS Fabricius

1. Antennal II strongly clavate on apical half, its thickness nearly twice that of I; length 5.5-6mm. ..... 518. *ater* (Linn.)

a. Legs and general color black ..... *a. ater* (Linn.)

Legs yellowish-brown or reddish ..... b

b. Head and pronotum black ..... *a. tyrannus* (Fab.)

Head and pronotum reddish ..... *a. semiflavus* (Linn.)

LXIII. COCCOBAPHES Uhler

1. Red with antennals I and II, tylus, tibiae, apices of tarsi and membrane black; beak reaching hind coxae; length 7.5-8 mm. ..... 519. *sanguinareus* Uhl.

LXIV. TROPIDOSTEPTES Uhler

1. Bright red with antennae, legs, except apices of hind and fore femora, space on either side of commissure of hemelytra and membrane black; beak not surpassing middle coxae; length 5.5-6 mm. ..... 520. *cardinalis* Uhl.

LXV. NEOBORUS Reuter

1. Dorsum practically glabrous 2

Dorsum distinctly pubescent 6

2. (1). Beak reaching middle of hind coxae; hemelytra with a black or red line along outer margin of radius and curving inward across apical part of corium; length 5.2-5.7 mm. ..... 521. *palmeri* Reut.

Beak not attaining hind margin of middle coxae 3

3. (2). Antennal I mostly pale 4

Antennal I mostly brownish-black; scutellum dark brown, basal angles pale; hemelytra dark brown to black with base of corium, embolium and area along radius pale; length 4.6-4.8 mm. ..... 525. *glaber* Kngt.

4. (3). Dorsum uniformly black with cuneus, except apically, and sometimes spot at base of corium pale; membrane dusky basally; length 4.8-5.3 mm. ..... 522. *geminus* (Say)

Dorsum more-or-less pale, frequently marked with red or black; scutellum usually with some yellow, but if black then membrane and cuneus pale 5

5. (4). Disk of frons alutaceous, with several deep punctures similar to those of vertex; scutellum with irregular, smooth median line; length 3.8-4.3 mm. ..... 523. *adustus* Kngt.

Disk of frons polished, with very faint punctures or impunctate; scutellum without indications of a smooth median line; length 4.3-5 mm. ..... 524. *amoenus* (Reut.)

a. Scutellum mostly pale ..... b

Scutellum and hemelytra, except cuneus and membrane, mostly black ..... *a. atriscutis* Kngt.

b. Membrane slightly smoky, paler adjacent to cuneus ..... *a. scutellaris* (Reut.)

Membrane wholly pale c
c. Chiefly pale, with apical area of corium usually reddish or black .....
.....*a. amoenus* (Reut.)
Very dark brown, almost black; lateral and median vitta of pronotum, all of scutellum except basal angles and median line at base, and corium more-or-less pale .....*a. signatus* (Reut.)

6. (1). Antennal I black 7
Antennal I pale 9

7. (6). Scutellum blackish along either side of pale median line, basal angles pale; corium and cuneus both translucent reddish-brown; length 4.6-4.9 mm. .....526. *rufusculus* Kngt.
Scutellum without median pale line 8

8. (7). Antennal II yellowish-brown, sometimes black near base; cuneus translucent yellowish to brown; length 4.7-5.3 mm. .....527. *canadensis* (VanD.)
Antennal II uniformly black; cuneus clear and translucent; length 4.2-4.6 mm. .....528. *populi* Kngt.

9. (6). Upper surface, including scutellum, black; cuneus pale translucent; legs pale; length 5.7-6.5 mm. .....529. *tricolor* (VanD.)
Upper surface more-or-less pale, scutellum pale with median black line extending from base to apex; legs pale; length 4-5 mm. .....530. *vittiscutis* Kngt.

LXVI. XENOBORUS Reuter

1. Antennal II not longer than basal width of pronotum; vertex less than one-third total width of head; length 5.7-6.3 mm. .....531. *pettiti* (Reut.)
Antennal II longer than basal width of pronotum; vertex less than one-third width of head; length 4.9 mm.....531½. *selectus* Kngt.

LXVII. LYGIDEA Reuter

1. Beak not surpassing hind margin of middle coxae; antennal II with several erect hairs, the length of each being greater than the diameter of the segment; cuneus mostly red; length 6.5-6.7 mm. .....532. *rosacea* Reut.
Beak reaching between hind coxae 2

2. (1). Color chiefly fuscous brown to blackish, ground color pale to greenish, never reddish; length 6 mm. .....533. *obscura* Reut.
Color orange-red, clavus, inner half of corium and usually the basal margin more-or-less fuscous to blackish; length 6.3-6.5 mm. .....534. *mendax* Reut.

LXVIII. NEOCAPSUS Distant

1. Shining; head, pronotum and scutellum orange-red; hemelytra black, cuneus of female reddish; scutellum finely but distinctly, irregularly transversely striate; length 5-5.9 mm. .....535. *cuneatus* Dist.

LXIX. LYGUS Hahn

1. Antennal II shorter than width of head; form ovate; yellowish- to dark reddish-brown, darkened with fuscous; length 4.5-5.2 mm. .....
.....536. *rubicundus* (Fall.)
Antennal II longer than width of head 2

2. (1). Beak reaching or surpassing hind coxae; hind tibiae pale 3
Beak not surpassing hind margin of middle coxae; scutellum yellow or bright green; length 4-4.2 mm. .....537. *campestris* (Linn.)

3. (2). Color yellowish to greenish, sometimes with darker markings 4
Color yellowish-brown to black or reddish, with darker markings 5

4. (3). Tibiae uniformly pale greenish, without fuscous at base; color of body chiefly green; length 4.5-5 mm. .....538. *apicalis* Fieb.
Tibiae with fuscous markings at base; upper surface and abdomen green; spot

behind each pronotal callus and a pair of short dashes at base of scutellum black; length 4.8-5.8 mm. .....539. *elisus* VanD.

5. (3). Hemelytra black and irregularly mottled with greenish-yellow flecks; head and anterior portion of pronotum yellowish-green, usually with two black rays behind each callus; length 5.3-6 mm. .....540. *plagiatus* Uhl.

Hemelytra sometimes dark, but not mottled with pale spots; head and pronotum not colored as above; upper surface distinctly pubescent 6

6. (5). Antennal II three times as long as I; frons uniformly yellow; length 6-6.3 mm. .....541. *frisoni* Kngt.

Antennal II less than three times as long as I; frons with median line darker; length 5-5.5 mm. .....542. *oblineatus* (Say) (Fig. 118)

LXX. NEOLYGUS Knight

1. Beak not surpassing tips of midcoxae 2
Beak reaching at least onto hind coxae 3

2. (1). Pronotum without longitudinal dark stripes; antennal II not darkened apically, its length less than basal width of pronotum; length 5.5-5.6 mm. .....543. *nyssae* Kngt.

Pronotum with a black stripe extending from each callus to hind margin; clavus and apices of corium and embolium also marked with black; length 5.8-6.2 mm. .....544. *vitticollis* Reut.

3. (1). Antennal II shorter than basal width of pronotum; general color greenish 4
Antennal II equal to or longer than basal width of pronotum 5

4. (3). Dorsum uniformly greenish with only a small fuscous mark extending from inner apical angle of corium transversely across anal area of membrane; length 5.2-5.7 mm. .....545. *neglectus* Kngt.

Inner margin of clavus dark brown; apical half of membrane clear with a fuscous margined spot either side of middle and one at tip of cuneus; antennal II not darkened apically; length 4.5-4.8 mm. .....546. *inconspicuus* Kngt.

5. (3). Antennal III shorter than IV; color brownish, hemelytra slightly darker, cuneus pale; length 4.8-5 mm. .....547. *geminus* Kngt.
Antennal III longer than IV 6

6. (5). Antennal I about as long as width of vertex plus one eye; length 4.9-5 mm. .....548. *geneseensis* Kngt.

Antennal I distinctly shorter than width of vertex plus one eye 7

7. (6). Antennal II at least two times as long as III 8
Antennal II shorter than twice the length of III 9

8. (7). Any or all of the following portions faintly to distinctly reddish: sides of body, hind femora and series of oblique lines either side of frons; pronotum sometimes darkened but never with fuscous rays behind the calli; length 5.6-5.7 mm. .....549. *quercalbae* Kngt.

Not marked with red as above; pronotum either all blackish or paler with short dark rays behind each callus, these sometimes very faint; length 4.8-6.3 mm. .....550. *caryae* Kngt.

9. (7). Hind femora and body above and beneath strongly marked with red 10
Not marked with red 11

10. (9). Pronotum with a black line behind each callus; length 5.4-5.8 mm. .....551. *communis* Kngt.

Pronotum without black lines behind calli; length 4.6-4.7 mm. .....552. *tinctus* Kngt.

11. (9). Pronotum with a small fuscous mark behind each callus; venter dark brown with pale lateral stripes; length 5.3-5.5 mm. .....553. *semivittatus* Kngt.
Pronotum without fuscous marks behind calli 12

12. (11). Antennal III longer than width of head; length 5-5.1 mm. ....554. *invitus* (Say)
Antennal III equal to width of head; length 4.6-5 mm. .....555. *tiliae* Kngt.

LXXI. DICHROOSCYTUS Fieber

1. Color uniformly green; antennal I longer than width of vertex; length 3.2-3.4 mm. .....556. *viridicans* Kngt.
Corium reddish; antennal I shorter than width of vertex 2

2. (1). Beak reaching between hind coxae; smaller, length 3-3.6 mm. .....557. *tinctipennis* Kngt.
Beak not surpassing middle coxae; larger, length 4.5-5.2 mm. .....558. *suspectus* Reut.

LXXII. BOLTERIA Uhler

1. Hemelytra yellowish, inner half of clavus, broad apical margin of corium and tip of cuneus dark fuscous; antennal II four times as long as I, the latter about three-fifths as long as width of vertex; length 4-4.3 mm. .....559. *luteifrons* Kngt. (Fig. 119)

LXXIII. POLYMERUS Hahn

1. Beak reaching first ventral; cuneus red, rarely paler; length 3.7-4.8 mm. .....560. *basalis* (Reut.)
a. Hemelytra mostly yellowish .....*b. basalis* (Reut.)
Hemelytra mostly dark brown or black .....*b. fuscatus* Kngt.
Beak not reaching hind coxae 2

2. (1). Beak reaching at least to front margins of middle coxae 3
Beak not reaching middle coxae 4

3. (2). Beak reaching hind margin of middle coxae; dorsum black, tip of cuneus and slender line on either side of fracture, and veins of membrane pale; length 5.3 mm. .....561. *proximus* Kngt.
Beak just reaching middle of middle coxae; dorsum black, tip of scutellum and basal angle of corium pale, cuneus yellowish, red and black; length 5.2-5.6 mm. .....562. *unifasciatus* (Fab.)

4. (2). Beak nearly reaching hind margin of mesosternum; legs nearly uniformly reddish-yellow, hind femora with a small group of fuscous points on anterior face near apex; cuneus with outer edge pale brown; length 4.6-5.2 mm. .....563. *punctipes* Kngt.
Beak not reaching beyond middle of mesosternum 5

5. (4). Tibiae entirely or with broad areas reddish-yellow 6
Tibiae black, usually with very little yellow 7

6. (5). Legs mostly red, apical third of femora black, tibiae yellowish with apices and variable basal area black; antennal II yellowish with apex very dark brown; length 5.2-5.7 mm. .....564. *venustus* Kngt.
Legs orange-yellow or fuscous; cuneus and embolium pale fulvous; dorsal pubescence deep golden; tibiae without black spots at bases; length 4.5-5.1 mm. .....565. *fulvipes* Kngt.

7. (5). Beak scarcely reaching hind margin of front coxae; hemelytra uniformly black, dorsum with silvery silky pubescence; length 4.7-6.4 mm. .....566. *gerhardi* Kngt.
Beak reaching or slightly surpassing hind margin of front coxae 8

8. (7). Embolium black; dorsum with silvery silky pubescence; length 5-5.9 mm. .....567. *venaticus* (Uhl.)
Embolium pale brown to yellow; femora deep yellow, apical third black, a pale ring showing faintly on anterior face; tarsi yellow, apical segment and claws black; length 5-5.7 mm. .....568. *flavocostatus* Kngt.

LXXIV. POECILOCAPSUS Reuter

1. Yellow or greenish-yellow with four spots on pronotum, basal angles of scutellum, two vittae on each hemelytron and a spot on center of cuneus black; length 7-7.5 mm. ..... 569. *lineatus* (Fab.) (Fig. 122)

LXXV. HORCIAS Distant

1. Antennal II clavate, its greatest diameter more than that of I; embolium white; cuneus rosy; length 5.2-5.8 mm. ..... 570. *illini* Kngt.
Antennal II with greatest diameter less than that of I 2

2. (1). Beak reaching between middle coxae; color black, scutellum frequently red; length 5.4-6 mm. ..... 571. *fallax* Reut.
Beak reaching hind coxae; color very variable (see appended key to color forms); length 6-7.2 mm. ..... 572. *dislocatus* (Say)

a. Color red and black ..... b
Color all black or black with white or yellow markings ..... g

b. Pronotum more or less black c
Pronotum uniformly red ..... d

c. Pronotum bivittate with black on basal half ..... *d. dislocatus* (Say)
Pronotal disk black on basal half but not bivittate ..... *d. goniphorus* (Say)

d. Hemelytra red or only slightly infuscated ..... e
Hemelytra broadly black or entirely black ..... f

e. Scutellum black ..... *d. coccineus* (Emm.)
Scutellum as well as whole dorsum red ..... *d. rubellus* Kngt.

f. Hemelytra uniformly black ..... *d. residuus* VanD.
Hemelytra with lateral margins red ..... *d. gradus* Kngt.

g. Pronotum not uniformly black ..... h
Pronotum uniformly black l

h. Scutellum uniformly black i
Scutellum with median line pale ..... j

i. Hemelytra with lateral margins broadly pale, claval suture never pale ..... *d. limbatellus* (Wlk.)
Hemelytra with lateral margins narrowly pale, claval suture bordered with white or yellow ..... *d. scutatus* Kngt.

j. Clavus not uniformly black ..... k
Clavus uniformly black ..... *d. nigriclavus* Kngt.

k. Claval suture bordered by black ..... *d. affinis* (Reut.)
Claval suture not bordered by black ..... *d. flavidus* Kngt.

l. Hemelytra uniformly black or only narrowly pale at base of radius .... m
Costal margin and frequently base of radius pale ..... *d. marginalis* (Reut.)

m. Legs pale testaceous, or blackish only at bases of femora ..... *d. pallipes* VanD.
Femora black, or only the apices pale, tibiae chiefly testaceous ..... *d. nigritus* Reut.

LXXVI. ADELPHOCORIS Reuter

1. Scutellum and hemelytra dark brown, latter with embolium and outer margin of cuneus pale; beak not surpassing hind coxae; length 6.8-7.5 mm. ..... 573. *rapidus* (Say) (Fig. 123)
Scutellum light with a fuscous line either side of middle, hemelytra pale with costal margin narrowly black; beak reaching second ventral; length 7-8 mm. ..... 574. *lineolatus* (Goeze)

LXXVII. STENOTUS Jakovlev

1. Color greenish-yellow to orange; tylus, two spots on pronotum and a pair of usually distinct stripes on hemelytra fuscous or black; length 6-7 mm. ..... 575. *binotatus* (Fab.)

LXXVIII. PARACALOCORIS Distant

1. Hind tibiae thickly clothed with long erect hairs which obscure the tibial spines and are easily confused with them; length 6-7 mm. ..... 576. *scrupeus* (Say)

a. Hemelytra with costal margin and corium similarly colored ..... b
Hemelytra with costal margin, or at least the cuneus, distinctly paler than corium i

b. Pronotum with dark markings in addition to discal spots c
Pronotum without dark markings other than discal spots ..... h

c. Pronotum and scutellum orange to pale red, former fuscous in front of discal spots and usually darker at basal angles ..... d
Pronotum otherwise marked ..... e

d. Corium brownish-black ..... *s. scrupeus* (Say)
Corium dark red, cuneus somewhat lighter ..... *s. rubidus* McA.

e. Pronotum very dark ..... f
Pronotum pale except for indistinct vittae and dusky maculations from discal spots to posterior margin, and between these and lateral margins; head, pronotum and scutellum with a broad, pale median vitta; corium yellowish-brown ..... *s. percursus* McA.

f. Scutellum dark ..... g
Scutellum chiefly yellowish or reddish; pronotum dark with median and two lateral areas pale ..... *s. triops* McA.

g. Scutellum piceous; pronotum with two lateral yellow areas ..... *s. diops* McA.
Scutellum dusky with median line pale; spots on clavus and corium yellowish-red ..... *s. delta* McA.

h. Corium reddish-brown with yellow spots ..... *s. compar* McA.
Corium except apex, clavus except base and narrow inner margin uniformly orange-red ..... *s. ardens* McA.

i. Cuneus and sometimes spots on corium lighter than corial color ..... j
Cuneus and costal margins entirely reddish or yellow ..... m

j. Pronotum orange to pale red, darker anterior to discal spots and at basal angles ..... *s. cunealis* McA.
Pronotal disk otherwise colored ..... k

k. Pronotum dusky or darker with three elongate, pale discal spots l
Pronotum, except discal spots, and anterior third, scutellum, cuneus and corial markings pale yellow ..... *s. lucidus* McA.

l. Scutellum dark, median line pale ..... *s. par* McA.
Scutellum clouded yellow ..... *s. sordidus* McA.

m. Pronotum without dark markings between discal spots and basal margins ..... n
Pronotum with dark markings between discal spots and basal margin .... o

n. Hemelytra V-shaped dark mark; embolar margins, scutellum and basal half of pronotum red or yellow ..... *s. bidens* McA.
Hemelytra with V-shaped black mark obsolete; dorsal surface, except base and inner apical angle of corium and narrow inner margin of clavus, reddish or yellow ..... *s. ardens* McA.

o. Pronotum with anterior third darkened ..... p
Pronotum with anterior third reddish or yellow ..... *s. bicolor* McA.

p. Scutellum dusky, median line pale ..... q
Scutellum yellowish with a dusky triangular mark either side of middle; corium and clavus spotted with yellow ..... *s. varius* McA.

q. Clavus and adjacent parts of corium dusky ..... *s. nubilus* McA.
Clavus and adjacent parts of corium spotted with reddish-yellow ..... *s. delta* McA.

Hind tibiae with short appressed hairs which are not easily confused with tibial spines; antennal I shorter than greatest length of pronotum 2

2. (1). Antennal I at least as long as width of head; pronotum and scutellum without distinct stripes 3
Antennal I shorter than width of head 4

3. (2). Antennal II with apical half black or very dark brown; scutellum with a narrow median yellowish line which may be obscured by brown; length 5.8-6.1 mm. .....577. *evonymi* Kngt.
Antennal II uniformly yellowish-brown, or with only extreme tip black; scutellum without a median pale line; length 6-6.4 mm. .....578. *salicis* Kngt.

4. (2). Upper surface dark brown with large yellow patches on apical half of scutellum, apex of clavus, middle of corium, apex of embolium and outer half of corium; three pale areas on pronotum; length 6-7 mm. .....579. *multisignatus* Reut.
Upper surface dark brown, light markings in form of lines and small dots 5

5. (4). Antennal II with median pale ring separating black on apex from brown on base 6
Antennal II without median pale ring; length 5.7-6 mm. .....583. *castus* McA.

6. (5). Beak surpassing hind coxae; length 5.5-7 mm. .....580. *celtidis* Kngt.
Beak not surpassing hind coxae 7

7. (6). Antennal II with only one pale ring and that submedian; femora dark at base, apical half with one large and several small white spots; length 5.4-5.8 mm. .....581. *gleditsiae* Kngt.
Antennal II with two pale rings, one submedian the other near base; femora with large pale areas near middle and base; length 5.8-6.5 mm. .....582. *colon* (Say)

LXXIX. GARGANUS Stal

1. Antennal II and upper surface black with median line of scutellum and outer margin and median line of hemelytra yellowish to white; under surface and legs orange-red; length 5.1-5.4 mm. .....584. *fusiformis* (Say)

LXXX. NEUROCOLPUS Reuter

1. Antennal I three-fifths or more as long as II 2
Antennal I not or only slightly more than half as long as II 3

2. (1). Antennal I nearly three-fourths length of II; beak surpassing hind coxae; length 5.6-6.7 mm. .....585. *tiliae* Kngt.
Antennal I not more than two-thirds as long as II; beak reaching posterior margin of hind coxae; length 6.5-7 mm. .....586. *nubilus* (Say)

3. (1). Hind femora pale with apical fourth black; length 6.3-6.5 mm. .....587. *jessiae* Kngt.
Hind femora fuscous or reddish on basal half; length 6-6.2 mm. .....588. *rubidus* Kngt.

LXXXI. PHYTOCORIS Fallen

1. Membrane either sprinkled with discolored or darker spots, or with numerous minute pale spots 2
Membrane either uniformly colored or marbled with paler, never with many small pale spots 10

2. (1). Antennal I slightly shorter than width of head, II dusky yellow to brown, pale at base; oblique brown band on basal half of corium joins with a brown band along suture; length 3.9-4.1 mm. .....589. *breviusculus* Reut.
Antennal I at least slightly longer than width of head, II mostly black, usually with white bands 3

3. (2). Antennal II black at base and with a pale ring just beyond, I longer than basal width of pronotum; length 5.1-6.2 mm. .....590. *antennalis* Reut.
Antennal II pale at base or entirely black 4

4. (3). Antennal III with pale band at base and middle; dorsum with both black and white scale-like hairs; lower half of propleura pale; length 5.9 mm. ..... 591. *conspurcatus* Kngt.

Antennal III with no median pale ring; antennal II pale at base and without or with only a very narrow median ring 5

5. (4). Hind femora dark brown, apical half with small dots only; length 7-7.6 mm. ..... 592. *fumatus* Reut.

Hind femora black, apical half with a pale band or numerous large pale spots 6

6. (5). Lower half of head black, or pale and marked with black 7

Lower half of head white; tylus blackish only at base 8

7. (6). Antennal II with pale band at middle; mesopleurae uniformly black; length 6.6-6.8 mm. ..... 593. *corticevivens* Kngt.

Antennal II without median pale band mesopleurae not uniformly black; length 5.3-5.5 mm. ..... 594. *purvus* Kngt.

8. (6). Antennal I equal to or longer than basal width of pronotum; length 5.9-6 mm. ..... 595. *albifacies* Kngt.

Antennal I shorter than basal width of pronotum 9

9. (8). Femora black, hind pair with an oblique, subapical white band and usually with a few pallid dots nearby; length 6.5-6.9 mm. ..... 596. *tuberculatus* Kngt.

Apical half of femora fuscous, with numerous large and small pale spots; length 6 mm. ..... 597. *sulcatus* Kngt.

10. (1). Antennal I longer than width of head across eyes 11

Antennal I equal to or shorter than width of head 26

11. (10). Antennae more black or fuscous than pale, if II has a broad pale median band then dorsum chiefly brown to black 12

Antennae more nearly pale, yellowish or reddish rather than fuscous or black; if II partly brown it is more pale than brown 17

12. (11). Corium with a distinct black or dark fuscous mark on apical half extending obliquely from radius to inner angle; pronotum not black 13

Corium fuscous, marked with numerous pale and brownish marks, but without oblique patch as described above; antennal II black with pale band at base; vertex narrower than the dorsal width of an eye; length 6-6.3 mm. ..... 604. *salicis* Kngt.

13. (12). Scutellum with distinct black mark on either side of apical half, this extending from lateral margin obliquely forward to near middle of disk 14

Scutellum with black spot on either side of apical half, this not extending more than half way to middle of disk 15

14. (13). Hind femora with large, irregular pale spots on anterior face, these attached by a longitudinal colorless line; length 6.8-7.6 mm. ..... 598. *onustus* VanD.

Hind femora with anterior face bearing small spots and no longitudinal lines; front of head with black, transverse striations on either side of median line; length 6-6.2 mm. ..... 599. *neglectus* Kngt.

15. (13). Hind femora with a pale ring on apical half and with numerous large and small spots; antennal II pale above 15a

Hind femora without a pale band on apical half 16

15a. (15). Propleura mostly black, only lower margin white; tibiae distinctly banded; length 5.7 mm. ..... 600. *canadensis* VanD. (Fig. 121)

Propleura mostly pale, with a longitudinal black line crossing coxal cleft; tibiae not banded; length 5.6 mm. ..... 601. *arundinicola* Kngt.

16. (15). Corium with a very heavy triangular black mark obliquely across apex; hind femora with two or three large white spots on dorsal surface; cuneus usually reddish; length 5.3-5.4 mm. ..... 602. *erectus* VanD.

Corium with a light, almost interrupted fuscous mark across apex; hind

femora with small pale spots only; cuneus not reddish; length 5.8 mm. .....603. *brevifurcatus* Kngt.

17. (11). Pronotal disk not marked with longitudinal reddish or orange vittae 18
Pronotum with four orange or reddish vittae 22

18. (17). Base of pronotum with four submarginal black spots; scutellum uniformly pale or with fuscous dots on apical half; length 4.7-4.8 mm. .....605. *quercicola* Kngt.

Pronotum not marked basally with black spots 19

19. (18). Scutellum uniformly yellow; hemelytra uniformly reddish, embolium and outer margin of scutellum paler; length 5.1-5.3 mm. .....606. *taxodii* Kngt.
Scutellum marked with reddish or fuscous 20

20. (19). Pronotum with base and lateral margins fuscous; scutellum yellow, marked with a red spot at either side of middle and without vittae at base; length 5.3-5.5 mm. .....607. *infuscatus* Reut.
Pronotum with extensive coloring 21

21. (20). Hemelytra with numerous small, distinct white spots; calli darkened with fuscous; length 4.6-5.5 mm. .....608. *confluens* Reut.

Hemelytra nearly uniformly deep orange-red, with faint white spots; calli pale; length 4.9 mm. .....609. *puella* Reut. (male)

22. (17). Antennal II with a slender black line on anterior face; length 5.1-5.5 mm. .....610. *tibialis* Reut.
Antennal II without a dark line on anterior face 23

23. (22). Corium with a large, yellow, triangular spot just before cuneus; clavus, base of corium, embolium and cuneus bright red, flecked with numerous small pale spots; length 4.5-4.9 mm. .....611. *venustus* Kngt.
Hemelytra not so marked 24

24. (23). Corium without net-like markings beyond tip of clavus; dorsal color pale greenish-yellow with dusky markings on hemelytra; length 5.2-5.3 mm. .....612. *caryae* Kngt.

Corium behind tip of clavus with net-like markings of orange or red 25

25. (24). Antennal I longer than width of head plus vertex; length 4.8-4.9 mm. .....609. *puella* Reut. (female)
Antennal I shorter than width of head plus vertex; length 4.1-5.1 mm. .....613. *depictus* Kngt.

26. (10). Antennal I red with yellow spots; length 4.8 mm. .....614. *rubellus* Kngt.
Antennal I not red with yellow spots; clavus and corium not uniformly colored 27

27. (26). Hemelytra pale, corium with an oblique fuscous mark on basal half and a second one on inner apical angle; cuneus pale with apex and two spots on inner margin black; length 4.1-4.3 mm. .....615. *junipericola* Kngt.

Hemelytra not so marked; pronotal disk without black spots; hind femora with a subapical pale band; cuneus reddish-brown laterally and with three or four pale dots; length 5.2 mm. .....616. *pinicola* Kngt.

LXXXII. PARAXENETUS Reuter

1. Antenna longer than body; color fuscous-brown; cuneus, veins of membrane and sometimes calli orange to reddish; membrane fuscous apically; length 6.4-7 mm. .....617. *guttulatus* (Uhl.) (Fig. 120)

LXXXIII. BARBERIELLA Poppius

1. Head and front lobe of pronotum brownish-black; hemelytra brown; strongly constricted at middle and with a transverse pale spot just behind narrowest part; beak reaching between middle coxae; length 5-5.5 mm. .....618. *apicalis* Kngt.

Annotated List of Species

HEBRIDAE

303.* *Hebrus concinnus* Uhl.—Our specimens were taken from the surface and beneath a board at the edge of a shallow, slow, spring-fed stream in Jefferson County in June, September and October.

304.* *Hebrus consolidus* Uhl.—Listed as occurring in Central America and from Kansas to Florida in the United States, this species will probably be found in Missouri.

305. *Hebrus buenoi* Drk. & Harr.—We have one specimen taken at lights in Scott County on September 5.

305½. *Hebrus burmeisteri* Leth. & Serv.—The only available Missouri record for this is found in Drake and Harris 1943.

306. *Merragata hebroides* White.—Numerous specimens were found on cow-ponds in Boone County during October and early November. Drake and Harris (1943) record it for the state.

307. *Merragata brunnea* Drk.—This species was found in considerable numbers on spring-fed ponds in Dent and Oregon counties during August.

MESOVELIIDAE

308. *Mesovelia mulsanti* White.—This species is to be found commonly on the surfaces of ponds. Adults have been found the year around, while available nymphal records are for the months of August, September and October. Adults may occur in apterous, brachypterous or macropterous conditions, the latter specimens frequently being found at lights. Boone, Cass (EHF), Clark, Dunklin, Franklin, Gentry (EHF), Jasper, Jefferson, Linn, Oregon, Pemiscot, Platte, St. Louis and Scott counties.

309. *Mesovelia cryptophila* Hgfd.—The recorded range of this insect includes Michigan, Iowa and Mississippi; therefore, it probably will be found in Missouri. It is said to occur along with *mulsanti* but to be more retiring in habit and to avoid open water.

CIMICIDAE

310. *Cimex lectularius* Linn.—This is the loathsome "bed bug" that so often feeds on man, especially in poorer sections of towns and in homes and buildings where travellers spend short periods. It probably breeds the year around in heated rooms as adults and immatures have been found during every season. It is also said to feed on rats, mice, rabbits, guinea pigs, horses, cattle and chickens. Although records at hand are relatively few, it undoubtedly is to be found throughout the state in many or all towns both large and small. VanDuzee (1917) implied that he had records for Missouri when he listed it for "All States." Horvath (1912) records some specimens taken in a hen house at Louisiana in Pike County. Boone, Greene, Jackson, Oregon, St. Charles, St. Louis and Stoddard counties.

* = *H. sobrinus* Uhl.: in examining the male genitalia of these and other specimens preparatory to making a revision of the Hebridae, T. Wayne Porter finds that his mid-continental specimens are all *sobrinus* and that the ranges of *concinnus* and *consolidus* are probably removed from Missouri.

311. *Cimex pilosellus* (Horv.).—Blatchley (1926) writes that this species is "Parasitic on various species of bats, and probably occurs with them throughout the entire United States." As several species of bats occur commonly in Missouri, this insect will undoubtedly be found here.

311½. *Cimex adjunctus Barb.*—A single specimen identified for us as this by Dr. R. I. Sailer was taken from a lumber pile in Pike County (CHB) on April 27.

312. *Oeciacus vicarius* Horv.—This species is said to occur in nests of swallows and chimney swifts as far west as Iowa and Colorado and so probably will be found in similar situations in Missouri.

ANTHOCORIDAE

313. *Lyctocoris campestris* (Fab.).—During the summer months adults and nymphs were found common in a hay loft. On an exceptionally warm day in early February this species was especially abundant among some straw covered boards in a moist field. Here, between the boards, large numbers of both adults and nymphs were active. Many of the adults and larger nymphs were seen to have their beaks inserted in small reddish Mycetophagid beetles, *Typhaea fumata* Linn. While feeding normally they had their beaks extended forward with the beetle impaled on its tip. When disturbed they crawled over the beetle and dragged it with their beak under their body. Several of the smaller nymphs were observed to be feeding on a small black and yellow Mycetophagid beetle, *Litargus nebulosus* Lec. Freshly transformed adults and mating pairs were also noted. Apparently both adults and nymphs occur throughout the year. Records for the former extend from February 9 to September 11, and for the latter from June 3 until August 28 and again in February. At least three instars were represented in the February material. Atchison, Greene (HIR), Holt, Pike and St. Louis counties.

314. *Lyctocoris stalii* (Reut.).—Both adults and nymphs have been found under bark. Records for the former extend from September 6 to April 6, but they will probably be found the year around. Fully grown nymphs have been found with adults during January, February and March. Bates, Boone, Carter (EHF), Dade, Henry (EHF), Maries, Montgomery, Phelps, Randolph, St. Louis, Saline (EHF) and Vernon counties.

315. *Lasiochilus fusculus* Reut.—Listed as occurring from New Jersey west to Illinois and south to Florida and Texas, this species probably will be found in Missouri.

316. *Xylocoris galactinus* (Fieb.).—Three specimens were found in the Japanese beetle traps in St. Louis, one each on June 15, August 18 and September 28.

317. *Asthenidea temnostethoides* Reut.—With a range that includes New York, Illinois, Texas and Florida, this species should occur in Missouri.

318. *Anthocoris musculus* (Say).—Sweeping of stream-side cottonwood

trees yielded both adults and nymphs on June 7 and additional adults on June 30, July 18 and 19. Cape Girardeau, Jefferson and Livingston counties.

319. *Orius insidiosus* (Say).—Adults have been found very commonly the year around, hibernating in grass clumps and under debris on the ground. During the active season this voracious little predator is to be found on the flowers and leaves of many species of plants. Here it feeds on many soft-bodied insects such as aphids and young caterpillars. If it happens to get on one's person it may occasionally insert its beak and cause a sharp pain which is little more severe than a pin prick. Nymphs have been observed from July 3 until October 11. Under the name *Anthocoris insidiosus* Riley (1876) records it as "quite common in Missouri." It has further been listed for the state under the generic name *Triphleps* by both Uhler (1876) and VanDuzee (1917). Atchison (EHF), Barry, Bates, Bollinger, Boone, Buchanan, Butler, Carter, Cass, Chariton, Crawford, Dunklin, Franklin, Gentry, Greene (HIR), Harrison (EHF), Howell, Jackson, Jasper, Jefferson, Laclede, Lawrence, Lincoln, McDonald, Macon, Miller, Montgomery, Newton, Oregon, Pemiscot, Pike, St. Charles, Ste. Genevieve, St. Louis, Shannon, Schuyler, Scotland, Stoddard, Texas, Vernon and Wayne counties.

ISOMETOPIDAE

320. *Teratodia emoritura* Bergr.—On June 6 a single pallid, teneral adult was found in the crevices on the trunk of an elm tree near St. Louis. At the time it was impossible to search for additional specimens. Three days later a return trip was made to the same spot. Visual examination of the limbs and trunks of eight elms, including that on which the original find was made, yielded no additional specimens. Sweeping was equally fruitless. Beating of medium-sized limbs, however, resulted in another adult, fully hardened and colored, and a single apparently fully grown nymph. These specimens are males.

321. *Diphleps unica* Bergr.—There is some doubt as to the exact status of this and the preceding species. McAtee and Malloch contend that *Teratodia emoritura* is but the male of this; while Reuter and Blatchley consider the two forms distinct. Solution of this problem awaits necessary field observations. Meanwhile, however, since *Diphleps unica*, as here defined, has been recorded as far west as Illinois, it might be found in Missouri.

CRYPTOSTEMMATIDAE

322. *Ceratocombus latipennis* Uhl.—Two male specimens were taken by sweeping low weeds in a moist meadow in Ste. Genevieve County on August 28. This find represents a great extension of range to the northeast. At first we took this to represent a new species, but Dr. R. I. Sailer of the National Museum, to whom one of the specimens was sent for verification, found that it "compares favorably" with the type of *latipennis*.

McAtee and Malloch's (1925) figure illustrating the forewing is somewhat misleading as it shows the triangular cell just exterior to the apex of the clavus

as being delimited laterally by a very distinct vein. Actually, this vein is very obscure and apparently visible only when the light passes through the hyaline corium.

Without recourse to this cell, *C. latipennis* Uhl. is characterized by the presence of lateral pronotal bristles, the single vein emanating from the apex of the discal cell of the fore wing and the presence of six or more pairs of fine hairs on dorsum of rostral II — all of these being indicated in McAtee & Malloch's (1925) key.

MIRIDAE

323. *Campylomma verbasci* (Mey.).—Dr. Knight (1941) writes, "This species came originally from Europe, but has long been established in North America. It is quite common almost everywhere mullein grows." As yet, our collecting on that host in Missouri has yielded no specimens.

324. *Chlamydatus suavis* (Reut.).—This very common species is frequently swept from ragweed, *Ambrosia trifida* Linn. Adults at hand are for the period from May 17 to September 21. Cass, Chariton, Clark, Dallas, Daviess, Dunklin, Harrison, Howell, Lafayette, Lewis, Macon, Mississippi, Perry, St. Louis, Schuyler and Taney counties.

325. *Chlamydatus associatus* (Uhl.).—We have taken adults commonly from *Ambrosia trifida* Linn., *Helianthus annuus* Linn., *H. occidentalis* Ridd. and *Xanthium pennsylvanicum* Wallr. between May 8 and October 11. Atchison, Boone, Buchanan, Cass, Cole, Crawford, Howell, Miller, Nodaway, Pemiscot, St. Charles, Ste. Genevieve, St. Louis, Schuyler, Scotland and Wayne counties.

326. *Plagiognathus nigrolineatus* Kngt.—Our single specimen was swept from second-growth scrub oak in New Madrid County on May 10. Its range is said to be coincident with that of its host, *Quercus macrocarpa* Michx., so it should be found throughout the state.

327. *Plagiognathus sericeus* (Heid.).—The ecological niche for this small form is the flowers of the linden tree, *Tilia glabra* Vent., with which it is concolorous. We have taken it commonly therefrom between June 9 and June 17. Boone, Buchanan, Jefferson and St. Louis counties.

328. *Plagiognathus gleditsiae* Kngt.—The recorded host and range of this species, which has been listed from honey locust in Illinois and Texas, indicates that it should be found in Missouri.

329. *Plagiognathus nigronitens* Kngt.—Specimens were swept from open Ozark woods between May 8 and 31 in Iron, McDonald and St. Louis counties.

330. *Plagiognathus politus* (Uhl.).—The typical form *politus* Uhl. and the color variety *flaveolus* Kngt. are both represented in the Missouri material at hand. The nominal form has been collected between June 10 and August 20, while the varietal form was taken from August 8 until September 31. Judging from the distributional data listed below, both forms are to be found

throughout the state. This is to be expected as the variety appears to be simply the second brood. Our field notes show form *politus* as very common on *Erigeron* and *Verbascum* in Adair, Audrain, Barry, Boone, Buchanan, Cape Girardeau, Carter, Cole, Dunklin (EHF), Greene (HIR), Howell, Iron, Jackson, Jasper, Jefferson, Knox, Lafayette, Lawrence, Lincoln, McDonald, Macon, Mississippi, Newton, Nodaway, Phelps, Pike, Randolph, St. Louis, Schuyler and Shannon counties. The form *flaveolus* Kngt. is represented by material from Atchison, Boone, Clark, Dunklin, Harrison, Jefferson, Laclede, Lewis, McDonald, Pemiscot, Platte, St. Charles, Ste. Genevieve, St. Louis, Scott, Taney and Webster counties.

331. *Plagiognathus cuneatus* Kngt.—The available specimens were collected throughout June in Barry, Jefferson, Phelps and St. Louis counties.

332. *Plagiognathus obscurus* Uhl.—A lone specimen of the color form *fraternus* Uhl. was collected in Buchanan county (EHF) on September 16.

333. *Plagiognathus negundinis* Kngt.—On May 27 a single specimen was taken in Boone county.

334. *Plagiognathus annulatus* Uhl.—This uncommon species is represented by three Missouri specimens taken during June in Carter, Maries and Phelps counties.

335. *Plagiognathus flavoscutellatus* Kngt.—Three specimens collected in Boone county on June 10 and 16 make up our only available material.

336. *Plagiognathus rosicola* Kngt.—A male paratype of this species, which was described in 1923, bore the data "June 12, Kansas City, Missouri (F. Rogers)." Blatchley (1926) and Knight (1941) both subsequently list it for the state. The original records at hand are from Boone and Newton counties during June.

337. *Plagiognathus blatchleyi* Reut.—The color variety *nubilis* Kngt. is a late appearing form, the available specimens having been collected between August 15 and September 21 in Boone, Green (HIR), Harrison (EHF), Jefferson, Laclede (EHF), Lewis, Livingston, Scotland (EHF) and Taney counties. We know of no Missouri records for the nominal form.

338. *Plagiognathus albifacies* Kngt.—Because it is known to occur as far west and south as central Illinois, we may expect to find this species in Missouri.

339. *Plagiognathus atricornis* Kngt.—Three specimens were swept from shrubby growth along a stream in Newton County on June 22.

340. *Plagiognathus tinctus* Kngt.—The color variety *debilis* Blatch. is represented by six specimens collected between May 25 and June 22 in Barry, Bollinger and Miller counties. The nominal form is not known to occur in the state.

341. *Plagiognathus punctatipes* Kngt.—The four Missouri specimens of

this apparently scarce species are from Bollinger and Iron counties on May 30 and 31 respectively.

342. *Plagiognathus dispar* Kngt.—Both color forms have been collected between May 25 and June 16. Boone, Gasconade, Miller and Ste. Genevieve.

343. *Plagiognathus similis* Kngt.—A moderate series was collected from the recorded host, *Betula nigra* Linn., in Gasconade county (EHF) on June 15.

344. *Plagiognathus salicicola* Kngt.—Having been recorded from Illinois and on willows on sand bars in the Mississippi River, this species will undoubtedly be found in Missouri.

345. *Plagiognathus delicatus* (Uhl.).—All of our specimens of this species have been swept from *Gleditsia tricanthos* Linn. between May 27 and June 3, but it should have a greater period of occurrence. It is listed for "Missouri" by Knight (1941). Bollinger, Boone, St. Louis and Schuyler counties.

346. *Plagiognathus guttulosus* (Reut.).—The few specimens seen during this study were from Barry, Morgan, Phelps and Saline counties and were collected during May, July, August and September.

347. *Plagiognathus repletus* Kngt.—Missouri specimens of the nominal form have been swept from *Juglans nigra* Linn. between May 29 and June 28 in Boone, Buchanan, Carter, Phelps, St. Louis and Texas counties. A single specimen of the color form was taken in St. Louis on May 27.

348. *Plagiognathus albatus* (VanD.).—Specimens have been taken in Missouri from *Juglans nigra* Linn. and *Platanus occidentalis* Linn., but more commonly from the latter. Adult records at hand are from June 2 to July 10. Barry, Boone, Livingston and St. Louis counties.

349. *Microphylellus modesta* Reut.—This species is rather common in Missouri. It has been collected from numerous plants, including *Ulmus americana* Linn., *Quercus* spp., *Althaea rosea* (Linn.) and *Helianthus annuus* Linn. between May 9 and June 12. Boone, Cole, Franklin, Iron, Jefferson, Pike (WSC), St. Louis, Schuyler and Texas counties.

350. *Microphylellus maculipennis* Kngt.—A few specimens of the nominal form are at hand from Dunklin and Stoddard counties on May 9 and from St. Louis county for May 29. The color form *fuscicornis* Kngt. is not known from Missouri.

351. *Rhinocapsus vanduzeei* Uhl.—Sweeping over an unkempt, weedy lawn in Iron County on May 31 resulted in the capture of a single specimen.

352. *Psallus seriatus* (Reut.).—This not uncommon species has been swept from weedy fields between June 17 and October 11. Knight (1926) recorded a specimen that he took July 22 at Hollister (Taney County) from *Croton texensis* (Klotzsch). Boone, Cass, Cole, Howell, Iron, Jefferson, Lafayette, McDonald, Maries, Pemiscot, Ste. Genevieve and St. Louis counties.

353. *Psallus amorphae* Kngt.—Our single Missouri specimen was collected in St. Louis County on June 3.

354. *Psallus bakeri* (Bergr.).—Dr. Knight says, "Occurs frequently in the states west of the Mississippi River" on *Artemesia*; so it probably may be found in Missouri.

355. *Lepidopsallus miniatus* Kngt.—A single specimen was collected in the lowlands in Stoddard County on May 9.

356. *Lepidopsallus nyssae* Johns.—This constitutes a "probable" species for the state, having been recorded for Texas and Illinois. It is said to occur on black gum, *Nyssa sylvatica* Marsh., a tree that grows in central and southern Missouri.

357. *Lepidopsallus rubidus* (Uhl.).—A copulating pair of the nominal form was swept from a weedy field in Boone County on June 10. The color variety *atricornis* Kngt. is not yet known from Missouri, but has been recorded for Illinois.

358. *Reuteroscopus ornatus* (Reut.)—This species is common on field weeds, including *Ambrosia*, between June 22 and September 24. Nymphs and tenereal adults have been collected during July and August. Audrain, Barry, Bates (EHF), Boone, Buchanan, Butler, Cape Girardeau, Carter, Cass, Clark, Chariton (EHF), Crawford, Dunklin, Gentry, Greene (HIR), Harrison, Iron, Jackson, Jasper (EHF), Jefferson, Laclede (EHF), Lafayette, Lawrence, Lewis, McDonald, Mercer, Montgomery, Newton, Nodaway, Perry, Phelps, Pike, Polk, Randolph, St. Charles, Ste. Genevieve, St. Louis, Saline, Schuyler, Scott, Taney (EHF), and Wayne counties.

359. *Reuteroscopus sulphureus* (Reut.).—Knight (1923) records this for Springfield (Greene Co.) on July 15 and Hollister (Taney Co.) for July 22. This state record is cited by Blatchley (1926). Our material was collected between June 2 and September 1. Barry (HIR), Boone, Cole, Clark, Dallas (HIR), Dent, Dunklin, Howell, Jasper, Jefferson, McDonald, Mississippi, Newton, Oregon, Phelps, Pike, St. Charles, Ste. Genevieve and St. Louis counties.

360. *Criocoris saliens* (Reut.).—Numerous Missouri specimens have been swept from bed-straw, *Galium* sp. Our specimens were collected from early May until June 19. Barry, Bollinger, Boone (AGP), Buchanan, Jefferson, McDonald, Miller, Phelps, St. Louis, Saline and Stoddard counties.

361. *Rhinacloa forticornis* Reut.—Knight (1927) records specimens from Hollister (Taney Co.) between the dates of September 5 and 10. He later (1941) again records it for "Missouri." I have seen no specimens from the state.

362. *Leucopoecila albofasciatus* Reut.—Knight (1927) records it—"Missouri—Aug. 21, 1916, Hollister (E. H. Gibson). Sept. 19, 1925, St. Louis (A. F. Satterthwaite), found to be injurious to grasses on golf greens." In

his "Miridae of Illinois" Knight (1941) repeats the economic note and the St. Louis record. Satterthwaite (1944) again publishes the St. Louis data and notes the injury to golf greens. Our specimens were collected from July 4 until October 23 in Pemiscot, Ste. Genevieve, St. Louis, Scott and Shannon counties.

363. *Atractotomus crataegi* Kngt.—This form is known only from Iowa, but its host plant, *Crataegus*, is found in Missouri so we may expect to find the insect here.

364. *Teleorhinus tephrosicola* Kngt.—In addition to Knight's (1941) "Missouri" record we have data from a specimen collected in Miller County on May 25.

365. *Coquillettia amoena* (Uhl.).—With a recorded range that extends as far north as Illinois and Iowa, this species should occur in Missouri.

366. *Orectoderus obliquus* Uhl.—This widely distributed species, which is known as far west as Colorado and as far south as New Mexico, might occur in Missouri.

367. *Macrotylus amoenus* Reut.—On May 29 and 30 this species was found in some numbers in Douglas, Stone and Taney counties.

368. *Cyrtopeltis varians* (Dist.).—This species is listed for "Missouri" by Knight (1941). It is said to "breed on cultivated tomatoes" and probably on related plants. We have seen no Missouri specimens during this study.

369. *Dicyphus agilis* (Uhl.).—Three specimens were swept from blackberry canes at the edge of a cultivated field in Bollinger County on May 30.

370. *Dicyphus vestitus* Uhl.—On March 25 and November 5 specimens were found among the leaves of mullein plants (*Verbascum*) in Boone and Maries counties. These records indicate that it hibernates in the adult stage.

371. *Macrolophus tenuicornis* Blatch.—Adults and nymphs of this species were swept from weeds along a fence-row in Buchanan County on July 28.

372. *Macrolophus brevicornis* Kngt.—A paratype for this species was recorded (1926) from "Missouri—♀ Forest Park, St. Louis." I have, as yet, seen no specimen from the state.

373. *Macrolophus separatus* (Uhl.)—One specimen was taken at lights in Cole County on September 23. Four additional ones were swept from the straggly plants of the floor of some Ozark woods in Oregon County on August 1.

374. *Hyaliodes harti* Kngt.—Adults of this fairly common species are usually swept from weedy fields, but some of our specimens were taken from wild grape, black locust and oaks. Imagoes have been collected between May 16 and September 16. Knight (1941) lists four paratype females from Springfield, Missouri, July 18, 1915 (HHK). Barry, Boone, Buchanan, Butler, Cape Girardeau, Carter, Harrison, Iron, Jasper, Lafayette, Lawrence, Mc-

Donald, Newton, Perry, Phelps, Pike, St. Louis and Vernon counties.

375. *Hyaliodes brevis* Kngt.—This species, which was described from Minnesota, Iowa and northern and central Illinois, might be found in Missouri.

376. *Hyaliodes vitripennis* (Say).—Our few specimens of the nominal form were collected between June 1 and August 29 in Buchanan and St. Louis counties. One of the St. Louis specimens was from cultivated grape. Riley (1871) lists it for the state under the generic name *Campyloneura*. The color form *dorsalis* Kngt. is much more common than the nominal one. It has been found from May 30 until September 1 on various plants, some on *Ulmus fulva* Michx., *U. americana* Linn. and *Celtis occidentalis* Linn. Buchanan, Cass, Dunklin, Jefferson, McDonald, Mississippi, Newton, Phelps, St. Louis, Scott, Stoddard and Texas counties.

377. *Monalocoris filicis* (Linn.).—Recorded as occurring on ferns as far west as Illinois and south to Florida, this species might reasonably be expected to occur in Missouri.

378. *Sixeonotus tenebrosus* (Dist.).—This species has been listed as occurring as far west as Kansas and so may be looked for in Missouri.

379. *Sixeonotus unicolor* Kngt.—Known as far west as Illinois and Mississippi, this species constitutes another "probable" for the state.

380. *Sixeonotus insignis* Reut.—Three Missouri specimens are at hand, two from at lights and one swept from roadside herbage. The dates are June 2, August 23 and September 5. Dunklin, St. Louis and Scott counties.

381. *Sixeonotus areolatus* Kngt.—More intensive collecting might find this species in the state. It is known from Alabama, Arkansas, Mississippi and Texas.

382. *Pycnoderes convexicollis* Blatch.—Described from Indiana and subsequently listed for Illinois, this little-known species might occur in Missouri.

383. *Pycnoderes medius* Kngt.—This species is found most commonly among plant growth along the edge of streams. It was described (1926) in part from Hollister (Taney Co.). That locality is repeated by Blatchley (1926). Knight (1941) again lists it from the state. Our adults were collected between June 22 and October 13. Barry, Boone, Dunklin, McDonald, Newton, Perry and St. Louis counties.

384. *Halticotoma valida* Reut.—Hibernation is accomplished as an egg imbedded in the leaf tissue of the host plant, *Yucca filamentosa* Linn. The egg is inserted at right angles to the leaf surface and only the very apex extrudes. Nymphs begin appearing by May 15. Apparently due to varying rates of hatching, by early June, before any adults are to be found, nymphs of all instars from freshly hatched to those in the fully grown condition were found together. This condition, all instars, continues until frost, which may be as late as the latter half of November. Adults begin appearing about June

7, and from then on until frost are to be found along with the nymphs. The feeding of this insect causes an unsightly yellowing of the leaves of the host. Cape Girardeau, Jefferson, Madison and St. Louis counties.

385. *Cylapus tenuicornis* Say.—This species, which is known as far west as Illinois, should occur in Missouri.

386. *Fulvius brunneus* (Prov.).—With a range that includes Kansas, Iowa and Illinois, this species will undoubtedly be found to occur in Missouri.

387. *Fulvius imbecilis* (Say).—The single specimen at hand was collected in Dunklin County on August 12. It is recorded for the state by Knight (1941).

388. *Peritropis saldaeformis* Uhl.—The inclusion of Illinois, Iowa and Oklahoma within its range makes it certain that this species should be found in Missouri.

389. *Peritropis husseyi* Kngt.—Known from Michigan, Illinois and Alabama, this species might occur in Missouri.

390. *Clivinema villosa* Reut.—Listed for Montana, Oklahoma and Texas, this species forms a remote possibility for the southwestern part of the state.

391. *Bothynotus modestus* (Wirt.).—Because it is listed for Illinois and Kansas we can safely assume the presence of this form in Missouri.

392. *Eustictus filicornis* (Wlk.).—This species is known to occur widely on its host plant, *Pinus echinata* Mill., which grows in the eastern section of the Ozark region of the state.

393. *Eustictus necopinus* Kngt.—A single male, apparently of the form *discretus* Kngt., is at hand from St. Louis on July 7. It has the entire dorsal surface of the pronotum, except collar and narrow margins, shining black.

394. *Eustictus salicicola* Kngt.—Two Missouri specimens are at hand: one swept from a stream-side poplar in Jefferson County on June 7; the other from Pemiscot County, August 11.

395. *Deraeocoris histrio* (Reut.).—Knight (1921) lists "Plesiotype: ♂ ♀ August 17, Langdon, Missouri (H. G. Barber)" and several more specimens from Langdon (Atchison Co.) collected by Barber on July 6, 10 and 14. We have found that this uncommon species breeds on *Polygonum coccineum* Muhl. (= *P. muhlenbergii* Meisn.) here as elsewhere. Records of imagoes are for the period from April 7 to July 19 and then several for the month of October. Atchison, Buchanan, Jackson (HIR), Lawrence (WWS) and St. Louis counties.

396. *Deraeocoris nebulosus* (Uhl.).—Adults of this common species have been found from May 17 until September 20. Our other records show it in some numbers from under loose or dead bark on oak, elm, hickory and other trees during January and February and indicate that it hibernates as an

adult and so should be found in that stage throughout the year. During the summer days it prefers to frequent the same type of place used in hibernating; at night it has often been found at lights. Uhler (1876) lists it for Missouri under the generic name *Camptobrochis*, which group is now considered to be a subgenus of *Deraeocoris*. Knight (1921) records "Plesiotype ♂ ♀ July 18, Springfield, Missouri (H. H. Knight)" and additional Missouri material as follows: adults and nymphs collected in July by C. V. Riley; adults from Charleston for the period from May 30 to July 28 (E. H. Gibson); adults from Springfield on July 18 (HHK) and adults taken at Hollister (HHK) on July 22 from white oak. Our specimens are from Barry, Boone, Buchanan, Carter, Cole, Greene (HIR), Jackson, Jasper, Lafayette, Lawrence, Linn, Miller, Mississippi, Nodaway, Pemiscot, St. Louis, Scott, Stoddard and Webster counties.

397. *Deraeocoris poecilus* (McA.).—This uncommon species has been collected under much the same conditions as was *D. nebulosus* during the months of May, June, August and December. Dunklin, Newton, Pemiscot (EHF), Randolph, Ste. Genevieve and St. Louis counties.

398. *Deraeocoris ornatus* Kngt.—Knight (1921) records a male from Whittenburg (Perry Co.) on July 12 and a pair collected in "Mo." by C. V. Riley. Blatchley (1926) lists it for the state under the name *Camptobrochis*. Later Knight (1941) again lists it for the state. Our two specimens were taken in Buchanan County on July 28 and in St. Louis County on September 6.

399. *Deraeocoris manitou* VanD.—Five specimens were taken from red cedar, *Juniperus virginiana* Linn., in Jefferson County on May 30 and June 7. Although Knight determined our first catch as his color variety *intermedius*, it appears to me that due to the large amount of pale color on the pronotum, scutellum and corium they fit better under his description of the nominal form.

400. *Deraeocoris sayi* (Reut.).—The four specimens at hand were all collected in the southeastern lowland section of the state. Each represents a different color variety. One collected in Butler County on May 11 is of the nominal form; two collected in Dunklin County on May 9 represent the two color forms *costalis* Kngt. and *unicolor* Kngt.; while the fourth specimen, which was taken in Stoddard County on May 9, is of the variety *marginatus* Kngt.

401. *Deraeocoris grandis* (Uhl.).—Uhler (1887) described it under the generic name *Camptobrachis* and lists among his type material a specimen "from Missouri, by Prof. Riley." VanDuzee (1917) includes "Mo." in his distributional data, but places it under the generic name *Camptobrochys*. We have a single specimen taken at lights in St. Louis County on June 7.

402. *Deraeocoris aphidiphagus* Kngt.—This species is apparently uncommon in Missouri. A fully grown nymph was found feeding on aphids on May 17. It transformed into an adult on May 28 without any other molts.

Our adult records cover the period from May 3 to July 7. Boone, Jefferson, St. Louis and Texas counties.

403. *Deraeocoris davisi* Kngt.—This is an oak-inhabitant, but is not very common in available collections. Adults have been collected during May and June. Carter, Cole, Iron, St. Louis, Schuyler and Shannon counties.

404. *Deraeocoris quercicola* Kngt.—All available specimens were collected between May 25 and June 29, most of them from the foliage of various oaks. Boone, Jefferson, Phelps, St. Louis, Schuyler and Shannon counties.

405. *Eurychilopterella brunneata* Kngt.—Since this species is known from the southern half of Illinois there is a possibility that it may be found in Missouri.

406. *Eurychilopterella luridula* Reut.—During the study of an introduced scale insect, *Parlatoreopsis chinensis* (Marl.), in St. Louis, a scale encrusted apple limb was brought into the laboratory. After being indoors several days the limb was noticed to have several active specimens of this Mirid on it. Under a binocular microscope they were seen to insert their beaks into the scale insects and apparently feed. So far, this is our only record of the species for the state.

407. *Hesperophyllum heidemanni* Reut.—This very widely distributed but rare species might occur in Missouri. Knight (1941) transferred this genus from its position in a separate family, the Termatophylidae, to its present position in the Miridae.

408. *Semium hirtum* Reut.—A not uncommon species, adults of which have been collected during August, September and October. Some of our specimens were taken from a species of *Euphorbia*, while all the rest were netted in general sweeping. Boone (WSC), Chariton (EHF), Clark, Harrison, Jefferson, Livingston (EHF), Morgan (EHF), Pemiscot, St. Charles, Ste. Genevieve and St. Louis counties.

409. *Parthenicus taxodii* Kngt.—This species was described from specimens collected from bald cypress, *Taxodium distichum* (Linn.), in southern Illinois. During a trip to southeastern lowlands of Missouri on July 19 we collected adults and on August 23 took both adults and nymphs in some numbers from that same host in Dunklin County.

410. *Parthenicus juniperi* (Heid.).—The recorded host, *Juniperus virginiana* Linn., has yielded a great many specimens of adults between April 29 and October 17. Our nymphal records extend from April 13 until May 27. Barry, Bollinger, Boone, Buchanan, Cole, Crawford, Franklin, Iron, Jefferson, Maries, Perry, Phelps, Ste. Genevieve, St. Francois, St. Louis, Shannon, Washington and Taney counties.

411. *Parthenicus nigrellus* Kngt.—An autotype of this species bears the label "St. James, Mo., VI-5, 1938 (R. C. Froeschner)." Our only specimen is from St. Louis County, June 14.

412. *Halticus intermedius* Uhl.—This species occurs as far north and west as North Dakota and Colorado and so should be found in Missouri.

413. *Halticus bracteatus* (Say).—This species, known in economic literature as the "garden flea hopper," is a serious pest of leguminous crops. It also feeds on cultivated and wild plants of several other families. Both the long and short winged forms occur together during the period from June 8 to November 4. Uhler (1892) records a specimen from "St. Louis, Mo., O. Lugger" under the synonym *H. uhleri* Giard. VanDuzee (1917) uses the name *H. citri* (Ashm.) for his "Mo." record which was undoubtedly taken from Uhler. Barry, Bates, Boone, Buchanan, Carter, Chariton (EHF), Dunklin, Jackson, Jasper, Jefferson, McDonald, Marion, Pemiscot, Perry, Pike, Platte and St. Louis counties.

414. *Strongylocoris breviatus* Kngt.—An autotype of this goldenrod-frequenting species bears the label, "St. Louis, Mo., R. C. Froeschner, June 14, 1938." Adults have been collected from May 24 until July 14. Buchanan, Butler, Franklin, Macon, Pike and St. Louis counties.

415. *Strongylocoris atritibialis* Kngt.—Specimens have been swept from ragweed, *Ambrosia trifida* Linn., along paths through woods between May 9 and June 23. Among the paratypes are listed (1939) the following Missouri records: ♂2♀ May 16, May 23, Glencoe; ♀ June 19, 1937, St. Louis (R. C. Froeschner)." Barton, Bollinger, Boone, Buchanan, Crawford, Franklin, Jasper, St. Louis, Saline and Schuyler (EHF) counties.

416. *Strongylocoris stygicus* (Say).—This insect has been swept commonly from field weeds, especially from goldenrod. Available specimens have all been taken between the dates of May 15 and July 17. Adair, Barry, Barton, Bollinger, Boone, Buchanan, Camden, Carter, Cole, Dallas, Dunklin, Franklin, Howell, Iron, Jackson, Jefferson, Phelps, McDonald, Macon, Maries, Miller, Newton, Pemiscot, St. Louis, Saline, Schuyler, Shannon (EHF) and Stoddard counties.

417. *Strongylocoris hirtus* Kngt.—Our specimens were all swept from weedy fields from May 30 until June 26. Boone, Jefferson and St. Louis counties.

418. *Strongylocoris mohri* Kngt.—Known from central Illinois, this recently described species might eventually be found in Missouri.

419. *Strongylocoris ambrosiae* Kngt.—Another probable species for Missouri, this one has been recorded from Iowa, South Dakota, Kansas and Texas.

420. *Hadronema militare* Uhl.—Two females were swept from along a weedy fence row in Linn County in north central Missouri on September 20.

421. *Lopidea instabilis* (Reut.).—This species, which was listed for the state by Knight (1941), has proven to be fairly common in oak woods in the Ozark section of the state between June 14 and July 4. Barry, Camden, Carter, Jasper, Lawrence (HIR), McDonald, Maries, Newton, Phelps, St. Louis and Shannon counties.

422. *Lopidea reuteri* Kngt.—The holotype, allotype and twenty of the paratypes from which this species was described (1917) were collected "July 22, 1915, Hollister, Missouri" (HHK) and were said to be "found breeding on witch hazel (*Hamamelis virginiana*)." It is again listed for the state by Blatchley (1926) and Knight (1941). Our only specimen was collected in Iron County on July 23.

423. *Lopidea robiniae* (Uhl.).—This species breeds on *Robinia pseudoacacia* Linn., but has proven to be less common here than it seems to be in other states. A single pair was collected on *Betula nigra* Linn., probably just a "sitting" record. June and July are the months during which adults have been collected. We have taken nymphs during May and June. Barry, Boone (TEB), Buchanan, Lincoln, Marion, Pike and St. Louis counties.

424. *Lopidea heidemanni* Kngt.—Our specimens were taken between the extremes of April 28 and June 17. Mr. W. W. Smith collected three specimens from hollyhock. Of the remainder, two were taken from hickory, while all the others were captured in general sweeping. Boone, Butler, Cape Girardeau (CHB), Cole, Crawford, Dallas, Franklin, Greene (HIR), Iron, Jefferson, Lawrence (WWS), McDonald, Maries, Newton, Phelps, Ste. Genevieve, St. Louis, Scott, Shannon, and Stoddard counties.

425. *Lopidea staphyleae* Kngt.—This appears to be a rather scarce species in Missouri. The few available specimens were collected between June 2 and 23. Barry, Boone, Iron, Jefferson and Saline counties.

426. *Lopidea confluenta* (Say).—In the original description (1832) it was listed as *Capsus confluenta* and said to inhabit "Missouri." Our only host-plant data list one specimen each from *Ambrosia trifida* Linn. and *Carya* sp. The other specimens were all taken in general sweeping during the period from May 30 to August 3. Knight (1918) recorded specimens he collected at Springfield, July 15-18. Barry, Bollinger (EHF), Boone (HEB), Butler, Carter, Dent, Iron, Jackson, Jasper, Lawrence, Lincoln, McDonald, Marion, Miller, Newton, Nodaway, Phelps, Pike, St. Louis, Shannon and Vernon counties.

427. *Lopidea teton* Kngt.—Two female specimens (identified by Dr. H. H. Knight) are at hand from Missouri. One was taken in Franklin County on May 24 the other in McDonald County on May 18.

428. *Lopidea davisi* Kngt.—The "phlox plant bug" often becomes abundant on cultivated phlox and occasionally does considerable damage to that plant in Missouri, as reported by Knight (1941). Our local specimens were taken from June 11 to August 19. Greene (HIR), Jackson, St. Louis and Warren counties.

429. *Lopidea incurva* Kngt.—The holotype male was listed (1918) for Langdon, Missouri, July 17. Blatchley (1926) and Knight (1941) both subsequently record it for the state. From June 22 to July 30 numerous specimens have been swept from *Gleditsia tricanthos Linn.* in Buchanan, Jackson, Jasper, Knox, Newton and Nodaway counties.

430. *Lopidea minor* Kngt.—The wide range of this species, which includes Illinois, Iowa and Mississippi, indicates that it should be found in Missouri.

431. *Lopidea salicis* Kngt.—One specimen was taken from *Carya* sp. in Ste. Genevieve County on June 5 and three more were found in Texas County on June 7.

432. *Lopidea amorphae* Kngt.—This species is said to occur on false indigo, *Amorpha fruiticosa* Linn., in Illinois, Iowa, Nebraska and Kansas and so will quite probably be found in Missouri.

433. *Lopidea lathyri* Kngt.—The range of this species includes Illinois and Oklahoma so it, too, will quite likely be found in this state.

434. *Lopidea media* (Say).—Our specimens were taken in general sweeping between May 13 and July 7. Knight (1918) records material collected by himself in Greene County on July 15. Barry, Bollinger, Boone, Camden, Cape Girardeau (EHF), Carter, Cole, Crawford, Iron, Jasper, Macon, Maries, Phelps, St. Louis, Saline, Schuyler and Shannon counties.

435. *Ilnacora malina* (Uhl.).—This species breeds commonly on orchard grass, *Dactylus glomeratus* Linn. Adult records extend from May 25 to June 28, while those of nymphs range from May 8 to June 7. It was described (1877), under the name *Sthenarops,* in part from material collected in Missouri by C. V. Riley. Boone, Buchanan, Carter, Howell, Lawrence (WWS), McDonald, Miller, Newton, Phelps, St. Louis, Schuyler and Texas counties.

436. *Ilnacora stalii* Reut.—Specimens were taken from hollyhock, sunflower, ragweed and in general sweeping between May 30 and October 13. Atchison, Boone, Buchanan, Cass, Dunklin (EHF), Gentry, Greene (HIR), Harrison, Howell, Jefferson, Lewis, Lincoln, Mississippi, Newton, Pemiscot, Pike (HIR), St. Louis, Saline, Schuyler, Scotland, Scott, Taney and Texas counties.

437. *Ilnacora divisa* Reut.—With a known range which includes Illinois, Iowa and Texas, this forms another probability for Missouri.

438. *Ilnacora illini* Kngt.—An autotype at hand is labelled "Cole Co., Mo., V-22, 1938 (R. C. Froeschner)." Our other specimens were also collected in May. McDonald, Newton and St. Louis counties.

439. *Diaphnidia pellucida* Uhl.—Since this species has been taken just across the Mississippi River at Grafton, Illinois, there seems to be no doubt but that it should also occur in Missouri.

440. *Reuteria fuscicornis* Kngt.—The recorded range of this species extends as far south and west as southern Illinois. It will, therefore, quite probably be found in Missouri.

441. *Reuteria irrorata* (Say).—Most of our specimens were collected from *Ulmus americana* Linn. Adult records are for June 19, 21 and July 12. Boone, Cole, Laclede, Lafayette and St. Louis counties.

442. *Reuteria querci* Kngt.—We have several specimens collected between June 13 and July 12. Boone, Butler, Carter, Jasper, Lafayette, Lawrence and McDonald counties.

443. *Reuteria bifurcata* Kngt.—Our two specimens were collected on June 19 and 29 in Boone and Iron counties.

444. *Reuteria platani* Kngt.—This species was described from specimens collected from sycamore in southern Illinois and so might reasonably be expected to occur on that host in Missouri.

445. *Melanotrichus althaeae* (Huss.).—Because it is often a pest on cultivated hollyhock, *Althaea rosea* (Linn.), this species has been given the common name of "hollyhock plant bug." In Missouri it is frequently seen on hollyhock plants in such numbers as to cause the leaves to become completely yellowed and killed. Adults and nymphs both apparently prefer to feed on the upper side of leaves in direct sunshine, even on the hottest days. When one approaches a heavily infested plant he can see young and old alike scurry over the edge of a leaf to seek safety on the under surface. Although the adults will quickly take to the wing, if the plant is jarred, they rarely fly any distance but quickly alight again. Adults and nymphs have been collected during the months from May until October. Audrain, Buchanan, Callaway, Jackson, Lincoln, Madison, Marion, Pike, Ralls, St. Louis and Warren counties.

446. *Melanotrichus flavosparsus* (Sahlb.).—Adults of this species, which breeds on lamb quarter, *Chenopodium album* Linn., occur during the period from May 9 to August 17. Nymphs have been found during June, July and August. Buchanan, Dunklin, Jasper, Lafayette, Nodaway and St. Louis counties.

447. *Melanotrichus catalus* (VanD.).—So far we have only a few specimens from the state. They were collected between April 29 and May 17. Crawford, Dallas and McDonald counties.

448. *Orthotylus chlorionis* (Say).—This uncommon species has been collected between May 12 and 31. Boone, Bollinger, Dunklin, Iron and Jackson counties.

449. *Orthotylus robinae* Johnst.—We have two males collected in Texas County on June 7.

450. *Orthotylus ulmi* Kngt.—The single specimen at hand represents a great westward extension of range for this species. It was taken in Buchanan County on June 28.

451. *Orthotylus taxodii* Kngt.—Described from and common in southern Illinois on bald cypress, *Taxodium distichum* (Linn.), it should be found on that same host in southeastern lowlands of Missouri.

452. *Orthotylus ramus* Kngt.—The three specimens at hand were collected on May 30 and June 7 in Bollinger and Jefferson counties.

453. *Orthotylus viridis* VanD.—Two specimens were collected in Barry County on June 22.

454. *Orthotylus basicornis* Kngt.—The two available specimens were collected at light; one in St. Louis on June 8 and one in Buchanan County (HIR) on June 26.

455. *Orthotylus rossi* Kngt.—Original localities for this species included Iowa and the full length of Illinois so it should occur in Missouri.

456. *Orthotylus notabilis* Kngt.—The recorded range includes Iowa and Kansas so we may look for this form in Missouri.

457. *Orthotylus submarginatus* (Say).—This species was originally described (1832) in part, under the generic name *Capsus*, from "One specimen in Missouri." It was subsequently listed for the state by Blatchley (1926) and Knight (1941). A single pair was taken in Schuyler County (EHF) on June 23.

458. *Orthotylus lateralis* VanD.—One specimen was swept from cottonwood, *Populus deltoides* Marsh., in Cape Girardeau County on June 10. It should occur throughout the state.

459. *Orthotylus dorsalis* (Prov.).—One specimen was taken in Boone County on May 29.

460. *Orthotylus modestus* VanD.—Two specimens of the nominal form are at hand; one from Bollinger County on May 30 and the other from Pike County on June 17.

461. *Orthotylus ornatus* VanD.—On May 9 and 10 several specimens were taken in Dunklin and Pemiscot counties.

462. *Labopidea ainslei* Kngt.—This form occurs widely in Illinois and Iowa so should be found in Missouri on its hosts, *Allium* spp.

463. *Labopidea allii* Kngt.—The common name "onion plant bug" has been given to this insect because it is often a serious pest of onions. Knight (1941) lists it for the state and reports, "In southern Missouri from 1934 to 1936, many plantings of Bermuda onions were destroyed." It not only attacks cultivated onions but also occurs on wild onions (*Allium cernuum* Roth. and *A. mutabile* Michx.) and wild garlic (*A. canadense* Linn.) from which it may migrate to cultivated plants. All available Missouri specimens have been collected between May 11 and June 26, but in Illinois it has been found as late as October. Boone, Butler, Cape Girardeau (CWW), Crawford, Franklin, Iron, Jasper, Jefferson, Miller, St. Charles, St. Louis, Stoddard and Vernon counties.

464. *Heterocordylus malinus* Reut.—We have two specimens collected on May 9 in Dunklin County. Knight (1927) records this species for "Missouri—♂♀(? C. V. Riley)" and later (1941) for "Missouri." It should occur widely within the state.

465. *Ceratocapsus rubricornis* Kngt.—As it is known to occur in Illinois and Mississippi, this forms a probable species for Missouri.

466. *Ceratocapsus lutescens* Reut.—Three specimens were taken by sweeping in a low, marshy woods in Butler County on July 4.

467. *Ceratocapsus fasciatus* (Uhl.).—A lone specimen is at hand from Nodaway County, July 30. In the original description, under the generic name *Megacoelum,* Uhler (1877) records some material for "Missouri."

468. *Ceratocapsus modestus* (Uhl.).—Our two specimens of this eastern species were swept from *Juglans nigra* Linn. in Buchanan County on June 28.

469. *Ceratocapsus pilosulus* Kngt.—This species occurs on various hosts as far west as Iowa and so may be found in Missouri.

470. *Ceratocapsus camelus* Kngt.—Dr. R. I. Sailer has furnished us with our only Missouri record for this species. A female, collected by W. W. Dowdy of Lincoln University, was taken in Cole County and identified for Dr. Sailer by Dr. H. H. Knight.

471. *Ceratocapsus nigellus* Kngt.—Specimens have been swept from Ozark woods during June. Camden, Dent and Phelps counties.

472. *Ceratocapsus taxodii* Kngt.—Sweeping on the recorded host, *Taxodium distichum* (Linn.), yielded several specimens on August 8 and 23. Dunklin County.

473. *Ceratocapsus vicinus* Kngt.—We have record of a single Missouri specimen without detailed data.

474. *Ceratocapsus apicalis* Kngt.—One specimen was collected in Linn County on September 30.

475. *Ceratocapsus setosus* Reut.—This insect is known to occur as far up the Mississippi Valley as Tennessee and southern Illinois and so should be found in at least the southern part of Missouri.

476. *Ceratocapsus complicatus* Kngt.—The holotype male of this species (1927) was collected at Hollister (Taney Co.) on July 22, 1915 (HHK). Later, apparently citing the original state records, Blatchley (1926) and Knight (1941) both list it for the state. A single specimen was taken in Buchanan County on July 28.

477. *Ceratocapsus pumilus* (Uhl.).—This appears to be our commonest member of the genus. It was frequently swept from willows between June 10 and September 19. Adair, Barry, Boone, Cole, Jasper, Laclede (EHF), Lafayette, Pemiscot, Perry and St. Louis counties.

478. *Ceratocapsus incisus* Kngt.—Our specimens were collected during the period from July 13 to September 19 in Knox, Laclede (EHF) and St. Louis counties.

479. *Ceratocapsus quadrispiculus* Kngt.—The states from which this species has been recorded include Illinois, Louisiana and Texas and so it might be expected to occur in Missouri.

480. *Ceratocapsus uniformis* Kngt.—Both the holo- and allotype of this

species were from Missouri (1927). The former was labelled "♂, July 18, 1915, Springfield, Missouri (H. H. Knight)"; while the latter bore the data "July 22, 1915, Hollister, Missouri (H. H. Knight)." It has subsequently been listed for the state by Blatchley (1926) and Knight (1941). Our only specimen was taken in Vernon County on July 8.

481. *Ceratocapsus digitulus* Kngt.—On July 1 one specimen was taken in Pike County.

482. *Ceratocapsus fuscinus* Kngt.—This species was recorded for "Missouri" by Knight (1941). We have two specimens collected in Livingston County on June 2 and Texas County on June 7.

483. *Sericophanes heidemanni* Popp.—Central Illinois appears to be the southern limit of range for this species so it should be found in at least the northern part of Missouri.

484.—*Cyrtopeltocoris illini* Kngt.—A paratype of this recently described (1941) species was collected at St. Louis on June 25. Another specimen was swept from a weedy field in Adair County on June 23. Our third specimen was found running over low weeds in an open woods in Jefferson County on June 7.

485. *Pseudoxenetus scutellatus* (Uhl.).—Adults are common on foliage of oaks in open woods from May 4 until June 23. Boone, Butler, Cape Girardeau (CWW), Cole, Dallas (EHF), Dunklin, Jefferson, Pike (WSC), St. Louis, Schuyler and Stoddard counties.

486. *Pseudoxenetus regalis* (Uhl.).—This species is less common than *P. scutellatus* but occurs with it on oak foliage. All of our adult specimens were collected during May. Dunklin, St. Louis and Stoddard counties.

487. *Alepidia gracilis* (Uhl.).—The very wide range covered by this species indicates that it should occur in Missouri.

488. *Alepidiella heidemanni* Popp.—Oklahoma, Maryland and Washington, D. C., are included in the range of this insect; therefore, it probably will be found in this state.

489. *Pilophorus vanduzeei* Kngt.—With a known range that includes Alabama, Illinois and Iowa this species should occur in Missouri.

490. *Pilophorus strobicola* Kngt.—This pine-inhabitant is known as far south as central Illinois and so may be looked for in Missouri.

491. *Pilophorus laetus* VanD.—We might find this southern form in Missouri as it is known to occur as far up the Mississippi Valley as Tennessee.

492. *Pilophorus taxodii* Kngt.—Collecting on *Taxodium distichum* (Linn.) in southeastern Missouri should yield this species. It was described from that host in the lowland section of southern Illinois.

493. *Pilophorus juniperi* Kngt.—On August 28 a lone specimen was swept from *Juniperus virginiana* Linn.; on June 20 another specimen was taken from the same host in Newton County.

494. *Pilophorus amoenus* Uhl.—With a range that extends as far south as Georgia and west to Illinois this species might be found to occur in Missouri.

495. *Pilophorus walshii* Uhl.—Adults and nymphs were swept in some numbers from isolated trees of *Gleditsia tricanthos* Linn. in a pasture on July 28. Our adult records extend from June 24 to September 15. Buchanan, Jasper and Lewis counties.

496. *Pilophorus brunneus* Popp.—Two specimens have been swept from *Populus deltoides* Marsh.; one on June 10 in Cape Girardeau County and the other on June 30 in Chariton County. Knight (1941) recorded it for the state.

497. *Mimoceps insignis* Uhl.—No Missouri specimens are available, but since this species occurs throughout the northern half of Illinois, there is a possibility that it might be found in Missouri.

498. *Collaria oculata* (Reut.).—Numerous specimens have been swept from marshy, open woods. One was collected from lights. Adult records from May 9 through August 23, while all nymphs have been taken in May. Butler (EHF), Dunklin, Iron, Perry (EHF), Pike, St. Louis and Stoddard counties.

499. *Collaria melleurii* Prov.—Ranging as far north as southern Illinois, this species should occur in Missouri.

500. *Miris dolobratus* (Linn.).—Adults are common on orchard grass, blue grass and other grasses in fields and along woodland borders between May 14 and June 23. The nymphs make their first appearance about April 8 and continue through May into early June. Adair, Bollinger (EHF), Boone, Buchanan, Carroll, Franklin, Jackson, Jefferson, Macon, Marion, Pike (WSC), Ste. Genevieve, St. Louis and Schuyler counties.

501. *Trigonotylus tarsalis* (Reut.).—Some of the available specimens were swept from *Spartina pectinata* Link, the slough grass, in a marshy field. Adults have been collected during July and August. Atchison, Lewis, Nodaway and Vernon counties.

502. *Trigonotylus brevipes* Jak.—Specimens have been collected at lights as well as in general sweeping during the months of June, July, August and October. Buchanan, Butler and Pemiscot counties.

503. *Trigonotylus ruficornis* (Geoffr.).—This species is common in weedy fields and at lights. Adults have been collected from June 8 to September 21. Audrain, Bates, Boone, Buchanan (HIR), Cass, Chariton, Cole, Harrison (EHF), Lafayette (EHF), Mercer, Pemiscot, St. Louis, Schuyler and Scott counties.

504. *Trigonotylus pulcher* Reut.—A common species of weedy fields that comes freely to lights. May 10 to October 27 represents extremes of adult captures. Barry, Boone, Buchanan, Cass, Cole, Gentry, Iron, Mercer, Pemiscot, Osage, Scott and Stoddard counties.

505. *Teratocoris discolor* Uhl.—In his original description Uhler (1887) records, "one specimen from near St. Louis, taken in May." VanDuzee (1917), Blatchley (1926) and Knight (1941) all list this species for the state, apparently basing theirs on Uhler's record. I have seen no Missouri specimens.

506. *Teratocoris paludum* Sahlb.—This species occurs on sedges in central Illinois so will probably be found on the same host in Missouri.

507. *Stenodema trispinosum* Reut.—One specimen in the collection of the University of Missouri bears the label, "Columbia, Mo., Aug. 6, 1924, E. T. Jones."

508. *Stenodema vicinum* (Prov.).—Listed as common in the eastern United States, this species is of probable occurrence in Missouri.

509. *Opistheuria clandestina* VanD.—A single specimen of the nominal form was collected in Pemiscot County on August 2. All the rest of our specimens are of the color variety *dorsalis* Kngt. and were taken in Mississippi and Pemiscot counties during August and October.

510. *Platytylellus confraternus* (Uhl.).—The recorded range extends from New England south to Florida and west to Michigan and Texas. However, Knight doubts that the records east of the 100th meridian are valid.

511. *Platytylellus nigricollis* (Reut.).—The two specimens placed here have the antennal and other structural characters ascribed to it, but differ slightly in color in that there is a distinct red spur extending from the collar back between the calli and onto the anterior pronotal disk. They were swept, along with *P. rubrovittatus*, from low weeds bordering a spring-fed pond in an Ozark wood in Shannon County on August 1.

512. *Platytylellus rubrivittatus* (Stal).—Numerous specimens were swept from low weeds around a spring-fed pond in a thick Ozark woods. All the others came from the southeastern lowland section of the state. Adults have been collected during August and October. Dunklin, Mississippi, Pemiscot and Shannon counties.

513. *Platytylellus fraternus* Kngt.—The nominal form is common and breeds on aromatic sumach, *Rhus canadensis* Linn. Adults have been collected during the period from May 22 to June 30. The color form *rubromarginatus* Kngt. is represented by one specimen from Shannon County, July 13. Adair, Boone, Carter, Cole, Macon, Maries, St. Louis and Texas counties.

514. *Platytylellus insitivus* (Say).—A lone specimen was taken in Carter County on June 16.

515. *Platytylellus nigroscutellatus* Kngt.—Our two St. Louis specimens were taken on June 5 and July 4.

516. *Platytylellus circumcinctus* (Say).—We have records from two Missouri specimens, both taken during June, one in McDonald and the other in Phelps counties.

517. *Platytylellus insignis* (Say).—This insect is said to be "Common over the eastern United States," (Knight 1941) so should be found in Missouri.

518. *Capsus ater* (Linn.).—An introduced European species that is reported as common throughout the eastern United States. It is apparently rare in Missouri as we have taken but a single specimen. It was swept from grasses in an open woods in Schuyler County on May 31.

519. *Coccobaphes sanguinareus* Uhl.—This species is rather scarce in Missouri. Adults have been collected during May and June in Buchanan (BOB), Cape Girardeau (CWW), Cole, Franklin, Jefferson, St. Louis and Stoddard counties.

520. *Tropidosteptes cardinalis* Uhl.—White ash, *Fraxinus americanus* Linn., is the host for this insect in Missouri as elsewhere. Adults have been collected from May 4 to June 7, while nymphs are at hand for most of May. Bollinger, Cape Girardeau (CWW), McDonald and St. Louis (JAD) counties.

521. *Neoborus palmeri* Reut.—A lone female is at hand from Boone County, June 27.

522. *Neoborus geminus* (Say).—This species should occur throughout the state on its recorded host, *Fraxinus americanus* Linn.

523. *Neoborus adustus* Kngt.—One specimen was collected from ash in Jackson County on August 3 and another in Buchanan County (HIR) on June 21. Type material of this species (1929) included the following Missouri material: "Holotype ♂, July 15, 1915, Springfield, Missouri (H. H. Knight); author's collection. Allotype: taken with the type. Paratypes: 26♂♀, taken with the types on ash (*Fraxinus* sp.) 5 ♂♀, July 18, 1915, topotypic."

524. *Neoborus amoenus* (Reut.)—Adults have been taken commonly from *Fraxinus americanus* Linn. from June 28 through October 8. Available nymphs were abundant on this host during the latter part of June and all of July. Barry, Buchanan, Clark, Dunklin, Jackson, Jasper, Lafayette, Lewis, Nodaway and Warren counties.

525. *Neoborus glaber* Kngt.—All of our available specimens were collected during May in Boone, St. Louis and Stoddard counties.

526. *Neoborus rufusculus* Kngt.—The known range of this species includes Illinois and Texas so its occurrence in Missouri is probable.

527. *Neoborus canadensis* (VanD.).—This is recorded from Illinois, Iowa, South Dakota and Texas so it might be found in Missouri.

528. *Neoborus populi* Kngt.—This species was described from *Populus deltoides* Marsh. in Illinois. Further collecting in Missouri should find it on the same host.

529. *Neoborus tricolor* (VanD.).—This species was listed for Missouri by Knight (1923 and 1941) and Blatchley (1926). We have seen no state specimens.

530. *Neoborus vittiscutis* Kngt.—A female was collected at Charleston (Mississippi County) on June 22, 1916 (E. H. Gibson) and recorded by Knight (1923) as a paratype. The species was subsequently listed for the state by Blatchley (1926) and Knight (1941).

531. *Xenoborus pettiti* (Reut.).—A single specimen of this species was found in the Japanese beetle traps in St. Louis on July 13.

531½. *Xenoborus selectus* Kngt.—The holotype male was collected "May 30, 1916, Charleston, Missouri (E. H. Gibson)." Except for this type locality record (1929) we have no information on this insect's occurrence in the state.

532. *Lygidea rosacea* Reut.—We have two Missouri specimens of this species. One is from Cape Girardeau County (EHF) and was collected on May 29. The other was taken in St. Louis County on July 13.

533. *Lygidea obscura* Reut.—Two specimens were swept from streamside willows on May 18 and 25 in McDonald and Miller counties.

534. *Lygidea mendax* Reut.—This is the "apple red bug" of economic literature. As to whether or not it will be found in Missouri still remains to be seen. However, it is known to occur west to the easternmost part of Iowa and so probably does occur in Missouri.

535. *Neocapsus cuneatus* Dist.—All of our specimens were collected during May. Knight records it for the state (1941). Butler (EHF), Crawford, Dunklin, Pemiscot, Ste. Genevieve and Stoddard counties.

536. *Lygus rubicundus* (Fall.).—Adults have been swept from willows and taken at lights between the dates of May 25 and August 9. Atchison (EHF), Barry, Buchanan, Cole, Dunklin, Jackson, Jefferson, Lafayette, Miller, St. Louis and Texas counties.

537. *Lygus campestris* (Linn.).—The recorded southern limit of range for this species is central Illinois so we might expect to find it in Missouri.

538. *Lygus apicalis* Fieb.—Except for two specimens which were taken on May 29, all of our specimens were collected during the period from September 17 to November 3. Knight (1917) lists specimens collected by himself at Springfield (Greene Co.) on July 18 and at Hollister (Taney Co.). Bates, Boone, Dunklin, Harrison, Jefferson, McDonald, Osage, Pemiscot, Pulaski, St. Louis and Wayne counties.

539. *Lygus elisus* VanD.—The "pale legume bug" is a western species that has been moving eastward in the last decade and a half. According to data on two specimens in the collection of the State Department of Agriculture it had already reached central Missouri by late in 1931. Adults have been collected on June 16 and again throughout the first half of September. Boone, Cole, Daviess, Harrison and St. Louis counties.

540. *Lygus plagiatus* Uhl.—During the summer months this species is commonly swept from *Ambrosia* and other field weeds. Dates on the adults at hand extend from March 31 to September 21. Knight (1917) records specimens collected by himself during July in Greene and Taney counties. He also lists specimens taken in Boone County on November 25 by C. R. Crosby; several from Jackson County which C. F. Adams took during June; and some collected by E. H. Gibson in Mississippi County during August. VanDuzee (1917) cites this state record. Blatchley (1926) also lists it for the state. Atchison, Boone, Buchanan, Cass, Harrison (EHF), Howell, Jackson, Jasper, Jefferson, Laclede (EHF), Lewis, Linn, Macon, Miller, Newton, Nodaway, Phelps, Pike, St. Louis, Saline, Taney and Texas counties.

541. *Lygus frisoni* Kngt.—This species was described from central Illinois and so might occur in Missouri.

542. *Lygus oblineatus* (Say).—The "tarnished plant bug" of economic literature has long gone under the name *Lygus pratensis* (Linn.). This latter is an European species which is known from the United States only in the extreme northeast. Under the name *Capsus oblineatus* both Say (1831) and Riley (1870) list this form for the state. Rau (1922) records it as *L. pratensis* (Linn.). We have taken adults the year around, hibernating under rocks, logs, mullein leaves and other objects on the ground. In the active season it feeds on numerous field and woodland border plants as well as being a serious pest on many nursery, ornamental and other cultivated crops. Nymphs have been found from April 23 until frost. Adair, Atchison, Audrain, Barry, Barton, Bates, Bollinger, Boone, Buchanan, Butler, Camden, Cape Girardeau (EHF), Carter (EHF), Cass, Clark, Clay, Cole, Crawford, Dallas, Daviess, Dunklin, Franklin, Gentry, Greene, Harrison, Holt, Howell, Iron, Jackson, Jasper, Jefferson, Knox (BOB & CHB), Lafayette, Lawrence, Lewis, Lincoln, Linn, Livingston, McDonald, Macon, Madison, Maries, Miller, Mississippi, Montgomery, Morgan (EHF), New Madrid, Newton, Nodaway, Oregon (EHF), Ozark, Pemiscot, Perry, Pettis (WRE), Phelps, Pike, Platte, Polk, Pulaski (EHF), Randolph, Reynolds, Ripley, St. Charles, Ste. Genevieve, St. Francis, St. Louis, Saline, Schuyler, Scotland, Scott, Shannon (EHF), Stoddard, Stone (EHF), Taney, Texas, Vernon, Wayne and Webster counties.

543. *Neolygus nyssae* Kngt.—This species is known to occur in southern Illinois and other states on sour gum, *Nyssa,* and so we may expect to find it on the same host in Missouri.

544. *Neolygus vitticollis* Reut.—We have two females collected on July 15 in St. Louis County (JAD).

545. *Neolygus neglectus* Kngt.—The range of this species extends westward from Ohio and Louisiana so should include Missouri.

546. *Neolygus inconspicuus* Kngt.—This Mirid has been listed as far west as Illinois and Oklahoma so will undoubtedly be found in Missouri.

547. *Neolygus geminus* Kngt.—This species was described from two lo-

calities in southern Illinois and so might reasonably be expected to occur in Missouri.

548. *Neolygus geneseensis* Kngt.—A paratype male was recorded (1917) for "June 16, Atherton, Missouri." It was subsequently listed for the state by VanDuzee (1917), Blatchley (1926) and again by Knight (1941). Our material was taken between May 10 and June 29. It occurs most commonly on various oaks. Boone, Butler, Camden, Cole, Iron, Jasper, St. Louis, Schuyler, Scott and Stoddard counties.

549. *Neolygus quercalbae* Kngt.—This species was recorded for the state by Knight (1941). Our material was collected between May 9 and June 17 in Crawford, Schuyler, St. Louis and Stoddard counties.

550. *Neolygus caryae* Kngt.—A single specimen of the color variety *subfuscus* Kngt. is at hand from St. Louis, June 1. Our nominal material was collected between May 17 and June 23 in Adair, Boone, Cole and Schuyler counties.

551. *Neolygus communis* Kngt.—The "pear plant bug" has been noted as being particularly damaging to pear fruits, the nymphs feeding on them in preference to foliage and twigs. Their feeding punctures cause the pears to become knotty and scarred. It has been recorded from Quincy, Illinois, which is just across the Mississippi River from northern Missouri and so will undoubtedly be found in this state.

552. *Neolygus tinctus* Kngt.—This Mirid was described from Illinois and Indiana and so might be expected to occur in Missouri.

553. *Neolygus semivittatus* Kngt.—Our series was collected on May 4, 9 and 10 and June 23 in Dunklin, Pemiscot, Schuyler and Stoddard counties.

554. *Neolygus invitus* (Say).—Material is at hand for the period from May 9 until June 24. Iron, Jackson, Jefferson, St. Louis, Stoddard counties.

555. *Neolygus tiliae* Kngt.—We have two specimens taken on May 29 and June 23 in Boone and Schuyler counties.

556. *Dichrooscytus viridicans* Kngt.—This species has been found on cedars, both wild and cultivated, during June, July and August. Buchanan, Jackson, Jasper, Jefferson, Reynolds and St. Louis counties.

557. *Dichrooscytus tinctipennis* Kngt.—Our specimens were collected on red cedar between May 3 and June 7. Bollinger, Franklin, Iron, Jefferson, St. Louis and Washington counties.

558. *Dichrooscytus suspectus* Reut.—Several specimens were swept from a cedar on an Ozark hillside in Taney County on September 15.

559. *Bolteria luteifrons* Kngt.—Adults occur on red cedar, *Juniperus virginiana* Linn., early in the season, available extremes of dates being April 27 and May 24. Our nymphal records extend from April 13 to 29. Although we made effort to do so, we failed to find adults after the above date. This

early season probably accounts for this species being so poorly known. Barry, Franklin, Jefferson, St. Louis and Washington counties.

560. *Polymerus basalis* (Reut.).—This common species has been swept from weedy fields during the period from May 18 to November 3. Boone, Buchanan, Butler, Carter, Cole, Daviess (EHF), Dunklin, Gentry, Greene (HIR), Harrison (EHF), Howell, Iron, Jasper, Jefferson, Lawrence (WWS), Linn, McDonald, Mercer, Mississippi, New Madrid, Newton, Nodaway, Pemiscot, Perry, Polk (HIR), Ste. Genevieve, St. Louis, Shannon (EHF), Taney and Wayne counties.

561. *Polymerus proximus* Kngt.—The allotype for this species was taken at Columbia (Boone Co.) on May 18, 1905, by C. R. Crosby. These data were recorded with the original description in 1923. Knight later (1926 & 1941) listed it again. Available adults are for the period from May 3 to June 7. Boone, Franklin, Jefferson, St. Louis and Schuyler counties.

562. *Polymerus unifasciatus* (Fab.).—The color form *lateralis* Hahn has been introduced into the United States from Europe and is now known to occur as far west as central Illinois and Iowa. It may, therefore, be found in Missouri.

563. *Polymerus punctipes* Kngt.—Adults have been swept from weedy fields between May 8 and July 2. Barry, Bollinger (EHF), Cole, Crawford, Franklin, Maries (EHF), Miller and St. Louis counties.

564. *Polymerus venustus* Kngt.—This species' known range extends as far west as Illinois and as far south as Florida, so further collecting will probably reveal its presence in Missouri.

566. *Polymerus gerhardi* Kngt.—This species has been recorded for Indiana, Illinois, Mississippi, Oklahoma and Texas so it may be looked for in Missouri.

567. *Polymerus venaticus* (Uhl.).—Our adults are for the period from May 8 to June 25. Cole, Franklin, Jefferson, Macon and St. Louis counties.

568. *Polymerus flavocostatus* Kngt.—Adults have been collected between May 24 to July 7. It was recorded for the state by Knight (1941). Cole, Bollinger, Franklin, Macon, St. Louis and Saline counties.

569. *Poecilocapsus lineatus* (Fab.).—The "four lined plant bug" is very common on many species of plants. It breeds most commonly on the flower stalk of a mullein, *Verbascum* sp. Nymphs have been found from April 23 until June 11. Adult records extend from May 5 to June 22. Say (1832) described his synonym of this, *Capsus quadr.vittatus*, in part from Missouri. Barry, Bollinger, Boone, Caldwell, Camden, Carter, Cole, Crawford, Franklin, Harrison, Jasper (EHF), Jefferson, Linn (EHF), McDonald, Macon, Mercer, Pemiscot, Phelps, Pike (WSC), Ste. Genevieve, St. Louis, Schuyler, Scotland, Shannon (EHF) and Texas counties.

570. *Horcias illini* Kngt.—We might expect to find this species in Missouri, as its type locality is in extreme southern Illinois.

571. *Horcias fallax* Reut.—The two Missouri specimens available for this study were collected in St. Louis and Franklin counties on May 8 and 24 respectively.

572. *Horcias dislocatus* (Say).—A very variably colored species which has been collected in the adult stage from May 8 to June 30. It apparently has many food plants, some of our specimens having been observed to feed on wild hyacinth, *Muscaria*, coral berry, *Symphoricarpos*, and grape flowers. In addition to the nominal form the following color varieties have been taken in the state: *flavidus* Kngt., *goniphorus* (Say), *gradus* Kngt., *marginalis* (Reut.), *nigriclavus* Kngt., *nigritus* Reut. and *rubellus* Kngt. Adair, Audrain, Bollinger, Boone, Carter, Cole, Crawford, Dallas, Franklin, Iron, Jefferson, Miller, Newton, Phelps, Randolph, Ste. Genevieve, St. Louis, Schuyler, Shannon and Texas counties.

573. *Adelphocoris rapidus* (Say).—The "cotton leaf bug" or "rapid plant bug" is very common in cultivated or weedy fields throughout the state. Nymphs begin to appear about the 25th of April and are to be found from then until September 2, at least so our records indicate. Adults were found from May 9 until November 3. Adair, Atchison, Barry, Bates (EHF), Bollinger, Boone, Buchanan, Camden, Cape Girardeau (CWW), Carroll, Crawford, Daviess, Dunklin, Franklin, Gentry, Harrison, Holt, Howell, Iron, Jackson, Jasper, Jefferson, Lafayette, Lawrence (WWS), Lewis, Lincoln, Livingston, McDonald, Macon, Madison, Mississippi, Montgomery (EHF), New Madrid, Nodaway, Pemiscot, Perry, Phelps, Pike, Polk, Randolph, St. Charles, Ste. Genevieve, St. Francis, St. Louis, Saline, Schuyler, Scotland (EHF), Scott, Stoddard, Taney, Vernon, Wayne and Webster counties.

574. *Adelphocoris lineolatus* (Goeze).—The "alfalfa plant bug" is an introduced European species. According to Knight (1941) it was first collected in Missouri in 1935. It is recorded as feeding by preference on the flower buds and newly formed seeds of alfalfa and sweetclover and so may prove to be a pest in fields where these crops are grown for seed. All of our specimens were collected during July. Atchison, Buchanan, Holt, Nodaway and Randolph counties.

575. *Stenotus binotatus* (Fab.).—Our adult specimens were collected from April 27 to June 11. It has been found breeding on orchard grass, *Dactylis glomerata* Linn., with nymphs appearing about May 22 and being present until June 7. Knight (1941) lists it for Missouri. Carter, Cole, Howell, Jefferson, Lawrence, Perry, Phelps, Ste. Genevieve, St. Louis and Texas counties.

576. *Paracalocoris scrupeus* (Say).—This fairly common species occurs most frequently on grape vines, but occasionally also on willow, hickory and other woody plants. In addition to the nominal form the color varieties *bidens* McA., *compar* McA., *cunealis* McA., *par* McA. and *varius* McA. have

been taken in the state. Adult records are for the period from May 22 to June 23. McAtee (1916) records a Missouri specimen collected by C. V. Riley. Barry, Bollinger, Boone, Cole, Jefferson, Phelps, Pike (WSC) and Schuyler counties.

577. *Paracalocoris evonymi* Kngt.—Our few specimens were collected between May 31 and June 22 in Macon, Pike (WSC) and St. Louis (HIR) counties.

578. *Paracalocoris salicis* Kngt.—Of the two available specimens, one was taken from *Populus* in Cole County on June 25, the other in the Japanese beetle traps in St. Louis on June 22.

579. *Paracalocoris multisignatus* Reut.—In Newton County on June 22 this species was found occurring commonly, along with *P. castus* McA., on flowers of *Vitis rotundifolia* Michx.

580. *Paracalocoris celtidis* Kngt.—This species is known to occur on *Celtis occidentalis* Linn. in both Illinois and Iowa. Additional collecting will probably find it in Missouri on that host.

581. *Paracalocoris gleditsiae* Kngt.—A pair was collected in Miller County on June 25 (EHF). Two more specimens were taken from honey locust in Bollinger County on May 30.

582. *Paracalocoris colon* (Say).—Central Illinois is the westernmost known limit of range for this species. Therefore, it might be found in Missouri.

583. *Paracalocoris castus* McA.—On June 22 numerous specimens were found on flowers of *Vitis rotundifolia* Michx.

584. *Garganus fusiformis* (Say).—This species is not very common in Missouri. Adults have been collected from June 8 to October 7. Knight (1941) lists it for the state. Buchanan (EHF), Carter, Dunklin (EHF), Mississippi, New Madrid, Pemiscot, St. Louis, Stoddard and Taney counties.

585. *Neurocolpus tiliae* Kngt.—Numerous adults and nymphs have been taken from the flowers and terminal growth of basswood or linden trees, *Tilia glabra* Vent. during June. Our adult records extend from May 29 to June 28. Boone, Buchanan and St. Louis counties.

586. *Neurocolpus nubilis* (Say).—The Missouri host for this common mirid is button-bush, *Cephalanthus occidentalis* Linn. Imagoes have been collected between April 6 and September 17, while all nymphs were taken during August. One adult was observed with its beak inserted into a pupa of *Lina interrupta* (Fab.) on willow. Two very pale specimens, which Knight identified as this, were taken from willows in a creek bed. Barry, Boone, Buchanan, Cass, Cole, Greene (HIR), Jackson, Jefferson, Lawrence (HIR), Lincoln, McDonald (EHF), Pemiscot (EHF), Polk, St. Louis, Saline, Shannon, Stoddard, Taney, Texas and Vernon counties.

587. *Neurocolpus jessiae* Kngt.—This species was described (1934) from Missouri material as follows: "Holotype ♂ July 3, 1921, Hollister, Mo. (Jessie Knight): allotype: same data as male. Paratypes: 6 ♂ taken with types. 2 ♂ July 18, 1915, Springfield, Mo. (H. H. Knight)." Knight (1941) later again lists it for the state. We have found nymphs in some numbers, with adults, on the flower clusters of elder, *Sambucus canadensis* Linn. Our adult records are from June 22 to July 15. Boone, Buchanan, Greene (HIR), Knox and Newton counties.

588. *Neurocolpus rubidus* Kngt.—With a known range that includes both Illinois and Kansas, this species forms a probable species for our local list.

589. *Phytocoris breviusculus* Reut.—May, June, August and September are the months during which our specimens have been collected. Boone, Carter, Gentry, St. Louis and Stoddard counties.

590. *Phytocoris antennalis* Reut.—The known range of this insect extends west to Illinois and Oklahoma. It will, therefore, quite probably be found in Missouri.

591. *Phytocoris conspurcatus* Kngt.—Of the material at hand, two specimens were taken from lights, one from the Japanese beetle traps and the remainder in general sweeping. June 7 to September 21 mark the range of dates for adults. Knight (1941) records it for the state. Jefferson and St. Louis counties.

592. *Phytocoris fumatus* Reut.—Although central Illinois is the recorded western limit of range for this species, it probably will be found to occur in Missouri.

593. *Phytocoris corticevivens* Kngt.—We have a single male collected in Jefferson County on April 29. Knight (1941) lists it for Missouri.

594. *Phytocoris purvus* Kngt.—Records for Iowa and southern Illinois indicate that this insect should occur in Missouri.

595. *Phytocoris albifacies* Kngt.—Although recorded only for Illinois and Mississippi, this species will probably be found on its host, the pecan, in Missouri.

596. *Phytocoris tuberculatus* Kngt.—This is another widely ranging species which Knight (1941) has recorded for the state.

597. *Phytocoris sulcatus* Kngt.—As Iowa, Illinois and Kansas are all included within the known range of this species, it should be found in Missouri.

598. *Phytocoris onustus* VanD.—With a range that extends as far west as Illinois, this species forms a "probable" for Missouri.

599. *Phytocoris neglectus* Kngt.—One specimen was collected in Iron County on May 29.

600. *Phytocoris canadensis* VanD.—The five available specimens were collected during June, July, August and October. Boone, Montgomery (WRE), Newton, Pike and St. Louis counties.

601. *Phytocoris arundinicola* Kngt.—Southern Illinois is the type locality for this species. It probably will be found in our state.

602. *Phytocoris erectus* VanD.—"Missouri" is listed by Knight (1941). We have three specimens taken on June 7, 28 and September 16. Atchison, Barry and Texas counties.

603. *Phytocoris brevifurcatus* Kngt.—This species has been collected in western Illinois and so should be looked for in Missouri.

604. *Phytocoris salicis* Kngt.—Sweeping on stream-side willows in Laclede County on September 19 yielded our only specimen.

605. *Phytocoris quercicola* Kngt.—Further collecting should reveal this species in the state since its known range extends as far north and west as Iowa.

606. *Phytocoris taxodii* Kngt.—This species occurs on bald cypress as far up the Mississippi Valley as southern Illinois and so should be found in Missouri on the same host.

607. *Phytocoris infuscatus* Reut.—Our only specimen was taken in Phelps County on June 16.

608. *Phytocoris confluens* Reut.—On August 2 one specimen was collected in Howell County (EHF).

609. *Phytocoris puella* Reut.—Locally this is a not uncommon species. Adults have been collected during June and September. Boone, Carter, McDonald and St. Louis counties.

610. *Phytocoris tibialis* Reut.—Adults were collected during August and October in Dunklin, Pemiscot and Ste. Genevieve counties.

611. *Phytocoris venustus* Kngt.—This is another probable species for Missouri, its recorded western limit of range being Illinois.

612. *Phytocoris caryae* Kngt.—This species has been found on hickory as far west as Illinois and so probably will be found on the same host in Missouri.

613. *Phytocoris depictus* Kngt.—A lone specimen was found in Phelps County on June 19.

614. *Phytocoris rubellus* Kngt.—The material at hand was collected between July 13 and October 7, some of them at lights. Knight (1941) lists it for the state. Buchanan, Cole, Pemiscot, Lewis and St. Louis counties.

615. *Phytocoris junipericola* Kngt.—Further collecting on red cedar should yield this species.

616. *Phytocoris pinicola* Kngt.—A specimen from Iron County was taken on June 29.

617. *Paraxenetus guttulatus* (Uhl.).—One specimen was collected in Pemiscot county on August 19.

618. *Barberiella apicalis* Kngt.—We have one specimen taken in Mississippi County on August 8.

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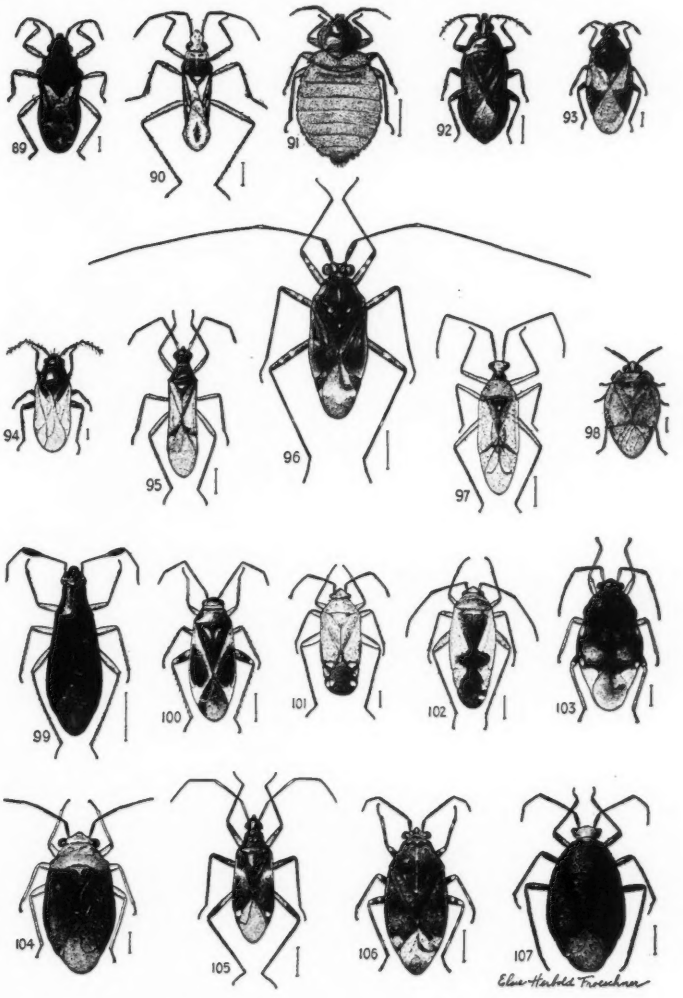

PLATE 9. FIGS. 89-107.—89.* *Hebrus concinnus;* 90. *Mesovelia mulsanti;* 91. *Cimex lectularius;* 92. *Lyctocoris stalii;* 93. *Orius insidiosus;* 94. *Ceratocombus latipennis;* 95. *Dicyphus agilis;* 96. *Cylapus tenuicornis;* 97. *Hyaliodes harti;* 98. *Teratodia emoritura;* 99. *Teleorhinus tephrosicola;* 100. *Plagiognathus repletus;* 101. *Macrotylus amoenus;* 102. *Reuteroscopus ornatus;* 103. *Pycnoderes medius;* 104. *Halticotoma valida;* 105. *Fulvius imbecilis;* 106. *Deraeocoris poecilus;* 107. *Bothynotus modestus.*

* = *H. sobrinus* Uhl.: see footnote page 155.

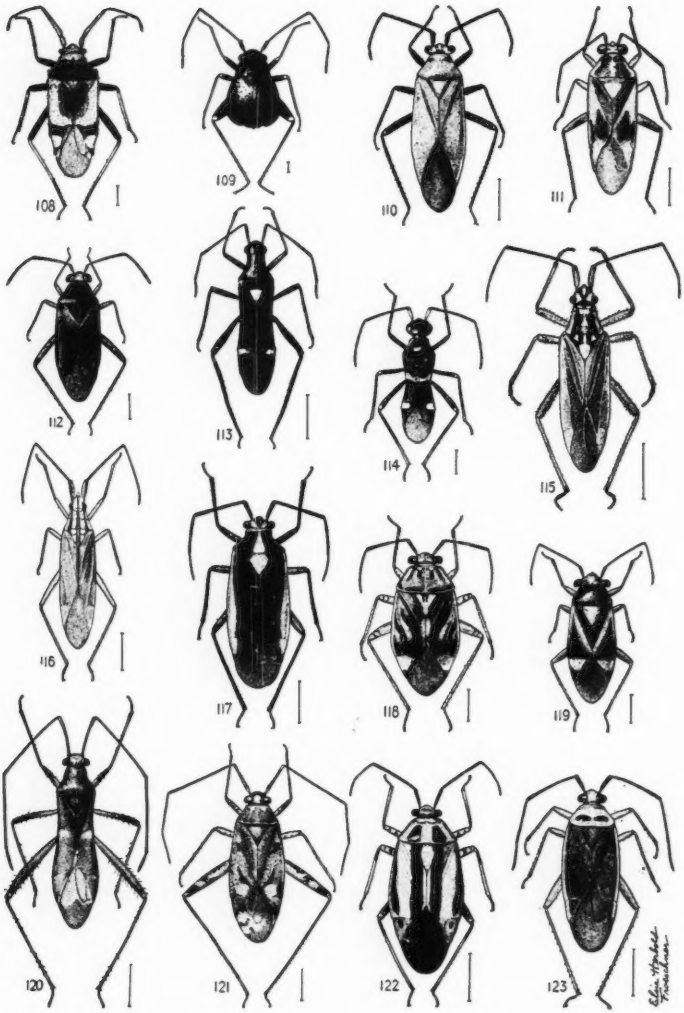

PLATE 10. FIGS. 108-123.—108. *Semium hirtum;* 109. *Halticus bracteatus;* 110. *Lopidea media;* 111. *Orthotylus ornatus;* 112. *Ceratocapsus modestus;* 113. *Pseudoxenetus scutellatus;* 114. *Cyrtopeltocoris illini;* 115. *Miris dolobratus;* 116. *Trigonotylus pulcher;* 117. *Platytylellus circumcinctus;* 118. *Lygus oblineatus;* 119. *Bolteria luteifrons;* 120. *Paraxenetus guttulatus;* 121. *Phytocoris canadensis;* 122. *Poecilocapsus lineatus;* 123. *Adelphocoris rapidus.*

The Developmental History of Latrodectus mactans (Fabr.) at Different Rates of Feeding*

Georgiana Baxter Deevey
Bingham Oceanographic Laboratory, Yale University, New Haven, Connecticut

CONTENTS

Introduction

This study of the developmental history of *Latrodectus mactans* (Fabr.) was undertaken in connection with a study of the blood and the moulting cycle of araneids. Previous work on the Haitian tarantula *Phormictopus cancerides* (Latreille) (Deevey, 1941) verified the reports of earlier investigators (Wagner, 1887; Kollmann, 1908; Millot, 1926) that there is a cycle in the blood cells which follows the moulting cycle. It seemed advisable to continue this study on a smaller form and one which moulted at frequent intervals, reaching maturity in a short time. The black widow spider was chosen, because it is abundant in the vicinity of Houston and since it lends itself so admirably to life in the laboratory, requiring a minimum of space as well as care. The first step in the problem was to raise numbers of spiderlings from egg to adult in the hope of delimiting the length of the various instars. Since no apparatus for controlling temperature and humidity was available only the amount of food received by the various series of spiderlings is known. In all, spiderlings from seven egg cocoons have been raised, giving a total of 278 males and 216 females from 633 spiderlings; 430 of these reached maturity. For these we know the length of each instar, the number of instars, and the age at maturity as well as the mean age at each instar for the series fed daily, those fed every other day, and those fed every four days. This is the material to be presented in this paper. Only two of the series were allowed to die a "natural" death after maturity; the mortality data for these spiders have already been published in the form of a life table (Deevey and Deevey, 1945). Here we are concerned mainly with the length and the number of the instars during the development of the black widow spider from egg to adult.

A general knowledge of the habits of *Latrodectus mactans* may be obtained from papers by Burt (1935), Herms, Bailey, and McIvor (1935), Blair

* Contribution from the Department of Biology, The Rice Institute, Houston, Texas.

(1934), Baerg (1923, 1945), Lawson (1933), D'Amour, Becker, and Van Riper (1936), and also Thorpe and Woodson (1945), who have written a general review of all aspects of the biology of this notorius species. The mating has been described by Herms, Bailey, and McIvor, while most of the authors cited have described the process of egg laying. Lawson, Blair, and Herms, Bailey, and McIvor gave full accounts of the development within the cocoon through the first moult, which occurs before emergence from the cocoon. The time required for the development within the cocoon varies. Herms, Bailey, and McIvor found this period to extend from 14 to 30 days, with 20 days as the average. Lawson reported a minimum of 15 days, although three to four weeks were usually necessary. D'Amour, Becker, and Van Riper observed that two to three weeks elapsed between the laying of the eggs and the emergence of the spiderlings, while Blair gave 25 days as the average time. In Houston, from September to May the observed period was one month, but this may be shortened during the summer. Shulov's (1940) experiments on the egg cocoons of the related species, *Latrodectus tredecimguttatus* and *L. pallidus*, showed that the temperature is the most important factor in determining the period of development within the cocoon. The eggs of *L. pallidus*, for example, hatched in three weeks to a month at an average temperature of 25° C., while at 20° C. more than forty days were necessary for their development, and at 15° C. the eggs began to develop and then died.

The number of moults that the black widow spider completes before reaching maturity varies considerably, as does the length of the developmental period. According to Herms, Bailey, and McIvor, in California the female moults six to eight times, with an average of seven times; the male averages five moults, although the range is from three to six. Blair reported that the female moults six times and the male five times in Alabama. In Kansas, Lawson found that the female undergoes seven to eight moults, the male only four. According to Burt, Illingworth (1931) reported eight to nine moults for the female in Hawaii, but gave no data for the male. Thorpe and Woodson recorded six to nine moults for the female and three to six for the male. In southeastern Texas the females moult seven to nine times, with the majority maturing at the eighth moult, while the male completes four to seven moults, although eight were recorded for one male. Despite uniform environmental conditions, in only one series did all the males or all the females from a single egg coccon mature at the same moult. All of the seven females fed maximally matured at the seventh moult.

The length of time necessary for development from emergence from the cocoon to maturity has been given as two to three months (Lawson), two to four months (Thorpe and Woodson), two months (Baerg, 1923), and one to two months (Illingworth), while a minimum of four months are required for the development from egg to adult, according to Herms, Bailey, and McIvor. In Houston, the minimum time recorded, including the month in the egg cocoon, was 56 days for males and 87 days for females, but 110 to more than 120 days was usual for females and males required 95 to 110 days when fed daily. The variation was therefore considerable.

In general, observations on the Texas black widow spider are in agreement with those made elsewhere. Females may be found at any time of year, although less frequently during the fall months. It is probable that there are two generations a year in the vicinity of Houston, at least under optimal conditions. Mature females were observed in the arid Salt Basin east of El Paso and in the Rio Grande Valley as well as in the vicinity of Austin and on the humid coastal plain around Houston. This distribution throughout Texas indicates that *L. mactans* can survive a wide range of environmental conditions. Burt (1935) observed that individuals of both sexes may overwinter, but it is improbable that adult males could survive for such a period. The males of the series to be considered in this paper died one to two months after attaining maturity. According to Shulov (1940), the males of *L. pallidus* and *L. tredecimguttatus* also live but a short while after becoming mature.

A number of egg cocoons were cut open in order to observe the rate of development. In two instances cocoons from different females contained lavender-pink eggs from which glassy pink spiderlings hatched, but all the other eggs examined were creamy white in color. Hatching occurred 15 to 20 days after the eggs were laid, the first moult taking place two to four days after this. At the first moult the spiderlings were 18 to 27 days old. Approximately five days later the spiderlings were ready to leave the cocoon. None left before the requisite time for development had elapsed, although the cocoons had been open for some time. Since the first moult occurs in the egg cocoon, the spiderlings emerged from the cocoon during their second instar.

ACKNOWLEDGMENTS

The rearing experiments on *Latrodectus mactans* were carried out at The Rice Institute. I am greatly indebted to Dr. Asa C. Chandler, Chairman of the Department of Biology, for granting me the facilities of the laboratory. Assistance with the care of the spider colony was made possible by the National Youth Administration. For advice and criticism of the manuscript I am extremely grateful to Dr. Alexander Petrunkevitch, Dr. Grace Pickford, and my husband Dr. Edward S. Deevey, Jr.

METHODS

The egg cocoons used in the experiments were made in the laboratory by mature females captured in the vicinity of Houston. On emergence from the egg cocoon, the spiderlings were placed in separate shell vials, plugged with cotton. Each spiderling was numbered and labelled according to the number of the maternal parent and the egg cocoon; for example, #19 II 100 referred to spiderling #100 from the second egg coccon of female #19. The history of each individual included the dates of feeding, eating, moulting, and any other pertinent data. The spiderlings were fed two to three *Drosophila melanogaster* per meal for the first few instars. Since both large and small mutants of these were available, the young spiders were given small ones at first, and later the larger ones. From the fourth to the fifth moult they received a house fly when available or four to five *Drosophila*. After the fifth moult they were given one housefly, *Calliphora, Calliphora* larva, or *Tenebrio molitor* larva per meal. During the young stages, up to the fourth or fifth moult, they were

given water on the cotton stopper approximately once a week. The *Drosophila* were lightly etherized before being fed to the spiderlings, since the latter could not readily catch fully active flies, but would eat them when etherized. Browning (1941) reported that the use of lightly etherized flies as food for immature *Tegenaria atrica* was legitimate. After the fourth moult the spiderlings were indifferent to such offerings and would pursue only active prey.

Table I lists the series raised, the number of spiderlings, the dates when the cocoons were made, the time of emergence, and the rate of feeding for each series.

TABLE I.—Data for the egg cocoons of *Latrodectus mactans* used in the rearing experiments, and the rate of feeding

Series	No. of Spiderlings	Date Cocoon Made	Date of Emergence	Rate of Feeding
19 I	25	Oct. 16, 1940	Nov. 19, 1940	Daily
19 II A	100	Jan. 9, 1941	Feb. 13–14, 1941	Daily
22 I	29	Oct. 12, 1940	Nov. 10, 1940	Daily
23 I	86	Jan. 1, 1941	Feb. 4–5, 1941	Daily
71 II	160	Nov. 1, 1941	Nov. 30–Dec. 2, 1941	Daily
28 I	108	Dec. 30, 1940	Feb. 1, 1941	Every two days
19 II B	108	Jan. 9, 1941	Feb. 13–14, 1941	Every four days

This list does not include Series 71 I. Female # 71 and her egg cocoon were collected by a friend and put in a jar with a wire-mesh cap. During the five day interval before their arrival at the laboratory, the spiderlings emerged from the cocoon, all but 17 escaping from the jar. These 17 spiderlings constitute Series 71 I. During their development they were fed once daily, but twice as much per meal as the other spiders fed daily. In the following pages this is termed maximal feeding.

INSTAR LENGTH AT DIFFERENT RATES OF FEEDING

The outstanding fact about the growth of *Latrodectus mactans* is the variation in the number and in the duration of the instars. In general, the length of the instars of araneids may be affected by such environmental conditions as the temperature, humidity, illumination, and the amount of food available to the spiderlings. This has been shown by Browning (1941), who raised third to sixth instar *Tegenaria atrica*, varying these conditions experimentally. The rearing experiments on *L. mactans* emphasized three types of variation: (1). Instar length varied depending on the rate of feeding; different series of spiderlings reacted similarly to the same feeding rate. (2). Within a series subjected to identical conditions, variations in instar length were related to the number

of moults completed before maturity. (3). Individual variations in instar length were always apparent. Throughout development no two spiderlings reacted in identical fashion to the same treatment, although individual variations were not as marked within a single group of males or females that matured at the same moult as within a series as a whole.

The effects of the various rates of feeding on the development of *L. mactans* are shown in graphical form in Fig. 1, which compares the mean instar lengths of the spiderlings fed maximally, daily, every other day, and every four days. From this it is apparent that at some period during development, regardless of the rate growth, there was at least one instar of appreciably greater length than the others. When the spiderlings were fed maximally (Series 71 I), the longest instar was always the one preceding the moult at which the spider attained maturity, while the earlier instars were of shorter duration. On the other hand, in the several series fed daily but not maximally the fifth instar was invariably the longest, excluding the ninth instar which involved only a small percentage of the females. In the series fed every two days and every four days the longer instars occurred at progressively earlier periods. Thus, when fed every two days (Series 28 I) the fourth instar was of greatest duration, approximately three weeks, but when fed every four days (Series 19 II B) the third instar was longest, although the second instar was also appreciably longer than in any of the other series. These several patterns are distinctive and were uniform for the great majority of the spiderlings of each series.

It is obvious that the rate of feeding, as well as the amount of food received, is of great importance to the spiderlings during their early development. According to Browning (1941), *Tegenaria atrica* completes the second moult without eating. This is not normally true of *Latrodectus mactans,* although the records showed that in one or two instances this did occur. Fig. 1 provides evidence that the newly emerged spiderlings required food immediately and that if a relatively constant supply was not available their early development was considerably retarded. Shulov (1940) also found that second instar spiderlings of *Latrodectus pallidus* and *L. tredecimguttatus* died relatively quickly if food was not available.

Fig. 1 also shows that once the fifth moult was completed the later development was fairly uniform for all the series, despite the varying rates of feeding. During their later instars the spiderlings fed every four days and every two days exceeded the spiderlings fed daily in the rate of their development. Once past the early instars, the spiderlings were apparently able to adjust to a low rate of feeding and to develop fairly rapidly in spite of minimal food. This ability to make up for lost time to a certain extent was most apparent in the spiderlings fed every four days (Series 19 II B). Browning has noted, similarly, that minimal food lengthened the fourth instar of *Tegenaria atrica,* but that the next instar with excess food was shortened. The fourth to seventh instars of Series 19 II B were successively shorter with minimal feeding throughout.

A comparison of the figures for the two series fed at lower rates (Series 28

I and 19 II B) in Table II, which gives the mean ages and the standard deviations for each series at each moult, shows that from the fifth moult onward the mean ages of these two series were similar although Series 19 II B received one half as much food per unit of time as Series 28 I. However, the higher standard deviations obtained for the spiderlings fed minimally (Series 19 II B) show that the age range of these spiderlings at each moult was greater than for the series fed at higher rates. The five series fed daily (see Table II) also

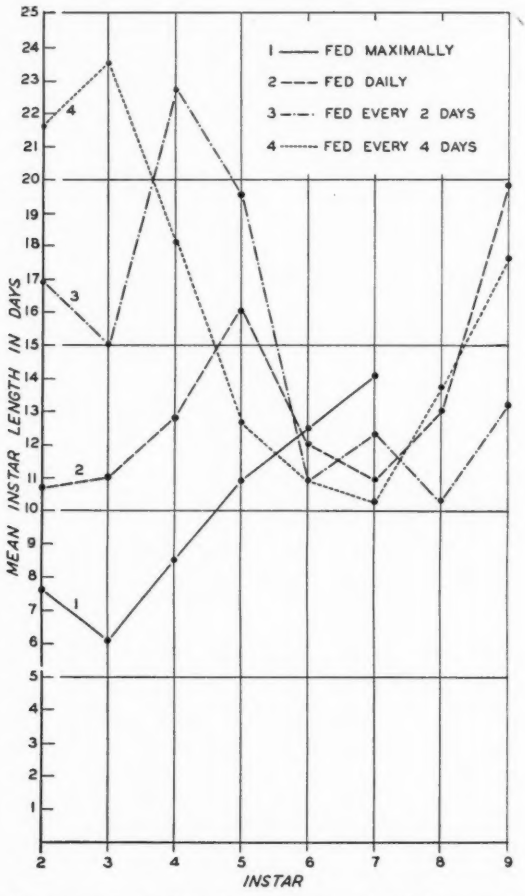

Fig. 1.—The mean instar length, in days, of the series of spiderlings reared at different rates of feeding. The length of the second instar includes only the period after emergence from the egg cocoon.

exhibited a considerable age range at each moult, the greatest variation in age occurring at the fifth and sixth moults.

The mean lengths of the instars in days and the standard deviations for each series of spiderlings are given in Table III. The representative data in this table are presented in Fig. 1. The figures for all the series are given in order to include the standard deviations which show the range of variation and to demonstrate the reactions of the several series fed daily to similar treatment. Mention must be made of one of these latter series, Series 71 II; the early development of these spiders was fairly rapid (see Tables II and III), but after the sixth moult many of the individuals refused to eat, so that their later instars were much longer than those of the other spiderlings fed at the same rate. For this reason in Table III figures are given for the mean instar lengths of the total number of spiders fed daily both including and excluding the data for the later instars of Series 71 II.

In general for all the series, excluding the ninth instar, the length range of

TABLE II.—Mean age in days after emergence from the cocoon, and the standard deviation, of each series at each moult

	2nd Moult	3rd Moult	4th Moult	5th Moult	6th Moult	7th Moult	8th Moult	9th Moult
Series Fed Maximally:								
71 I	7.6	12.7	21.1	31.7	40.6	56.7	—	—
	1.0	3.1	4.4	6.4	7.0	6.0		
Series Fed Daily:								
19 I	9.2	21.7	40.0	60.0	71.8	79.0	90.7	96
	2.0	4.2	2.5	6.4	5.0	3.4	5.0	
19 II A	13.6	25.5	39.8	57.0	68.0	76.4	86.5	—
	2.9	3.3	4.4	4.6	4.5	4.6	3.0	
71 II	9.6	20.2	29.7	45.0	57.0	75.0	91.5	121.6
	2.4	2.6	4.2	4.8	6.1	10.9	18.5	9.8
23 I	11.2	23.3	38.2	55.7	66.4	76.0	88.6	97
	2.8	2.6	2.6	2.0	2.8	2.4	1.7	
22 I	8.1	18.0	37.4	65.2	75.4	85.0	99.0	105
	1.3	1.9	5.2	6.1	3.8	3.9	6.2	
Series Fed Every 2 Days:								
28 I	16.8	31.5	54.4	74.0	84.4	95.8	105.0	114.8
	3.4	2.7	4.3	3.4	4.7	3.1	3.9	3.4
Series Fed Every 4 Days:								
19 II B	21.4	44.6	63.1	75.7	87.0	94.5	107.7	114.6
	4.9	5.8	6.9	6.9	6.8	6.2	6.8	11.6

the instars was from one to three weeks, although with maximal feeding the longest instar was approximately two weeks in length. The ninth instar was erratic in occurrence and of variable duration. From all the series a total of nineteen females completed nine moults. For ten of these spiders, the ninth instar was ten to sixteen days in length. Six of the remaining spiders, belonging to Series 71 II, spent 24 to 54 days in this instar, but this must be considered abnormal. There was only one other instance of an excessively long ninth instar; this occurred in another of the series fed daily (Series 19 I) and was responsible for the high mean length of this instar in this series (see Table

TABLE III.—The mean length of the instars in days, and the standard deviation, for each series of spiderlings

	2nd	3rd	4th	5th	6th	7th	8th	9th
Series Fed Maximally:								
71 I	7.6	6.1	8.5	10.5	12.5	14.1		
		0.6	2.0	2.8	1.6	1.1		
Series Fed Daily:								
19 I	8.2	12.3	17.5	20.3	13.0	10.5	13.4	24.3
	1.9	3.9	3.5	1.7	2.6	1.6	3.3	16.1
19 II A	13.6	11.7	14.1	17.1	11.5	11.1	11.8	
	2.8	2.0	2.9	3.5	2.6	1.6	1.3	
71 II	9.8	10.7	9.5	15.4	12.1	18.3	23.1	38.5
	2.4	2.1	2.3	3.7	5.3	8.9	12.0	11.2
23 I	11.2	12.3	14.8	17.9	11.0	10.9	14.0	12
	2.8	2.0	2.1	2.7	2.4	1.8	1.0	
22 I	7.5	9.5	17.9	27.8	13.9	10.5	15.0	17.0
	1.0	1.6	5.6	5.8	3.1	2.0	3.0	3.0
Total Fed Daily	10.7	11.1	12.8	16.1	12.0	14.0	15.7	29.2
	4.0	2.5	4.4	5.4	3.9	7.6	9.0	14.8
Total Fed Daily Excluding 71 II						10.9	13.0	19.8
Series Fed Every 2 Days:								
28 I	16.9	15.0	22.7	19.5	10.9	12.3	10.3	13.2
	3.1	2.8	4.0	4.1	2.8	2.0	2.0	2.4
Series Fed Every 4 Days:								
19 II B	21.6	23.5	18.1	12.7	10.9	10.3	13.7	17.6
	5.1	5.6	5.1	4.5	2.5	1.8	3.9	6.0

III). For the majority of the spiders the ninth instar required one and one half to three weeks.

In addition to the variation in the period of occurrence of the longest instar (see Fig. 1 and Table III) that was dependent on the rate of feeding, there were also within a series variations in instar length related to the number of moults the spiderlings completed before attaining maturity. Table IV gives the mean lengths of the instars, in days, of the males of each series that matured at the various moults, while Table V presents these data for the females. When these tables are examined and the several groups from a single

TABLE IV.—Mean length of the instars, in days, of the males maturing at the various moults

Series	Rate of Feeding	2nd	3rd	4th	5th	6th	7th	8th
71 I	Maximal		6.0	11.5				
			6.0	10.8	13.8			
			7.0	9.0	9.0	16.0		
19 I	Daily	8.3	10.6	27.0	18.0			
		9.0	12.0	19.9	21.6	13.0		
		10.0	11.0	15.0	20.0	11.0	12.6	
19 II A	Daily	13.7	12.0	18.2	18.0			
		13.2	12.0	15.0	17.9	13.7		
		13.0	12.0	12.5	15.3	9.0	14.0	
71 II	Daily	8.0	10.0	9.0	21.0			
		9.5	9.4	9.0	17.2	21.1		
		9.6	10.9	9.7	15.5	11.0	20.8	
22 I	Daily	7.3	9.6	21.0	31.1			
		7.5	11.5	24.5	24.0	13.5		
		8.7	10.5	18.3	23.5	12.7	13.3	
23 I	Daily	9.4	13.3	16.0	19.8	14.5		
		10.3	11.8	14.7	17.2	10.9	13.3	
Total Fed Daily:		9.4	10.3	20.6	25.4			
		11.4	11.7	15.3	18.8	13.1		
		10.0	11.2	11.1	16.2	11.0	17.4	
Excluding 71 II							13.3	
28 I	Every 2 Days	16.7	17.9	23.3	19.1			
		18.3	15.4	22.6	21.4	15.9		
		16.9	15.0	22.3	19.6	10.4	14.0	
		17.0	12.0	21.0	20.0	16.0	11.0	9.0
19 II B	Every 4 Days	21.3	25.6	19.1	12.3	11.6		
		21.5	20.3	18.3	14.2	10.2	10.5	

series are compared, both of these types of variation are apparent. Differences in instar length related to the number of moults completed were most obvious in males reared at the higher feeding rates, and were less apparent in males whose early instars were lengthened by minimal feeding and in females whose developmental period was invariably longer than that of males reared under similar conditions. Fig. 2 demonstrates in graphical form the variations in instar lengths noted for the total number of males fed daily that matured at the fifth, sixth, and seventh moults. From the fourth instar onward the instars were progressively longer for the males completing the smaller number of moults. Thus the total mean instar lengths for the fourth instar of these

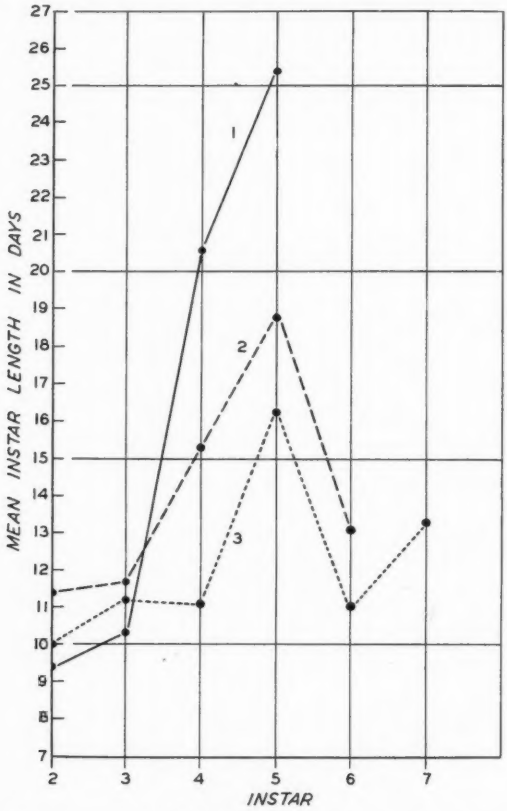

Fig. 2.—The mean instar length, in days, of the total number of males fed daily that matured at the fifth, sixth, and seventh moults. 1. Males mature at the fifth moult; 2. Males mature at the sixth moult; 3. Males mature at the seventh moult.

males (see Fig. 2 and Table IV) were 20.6 days for the males maturing at the fifth moult, 15.3 days for males maturing at the sixth moult, and 11.1 days for the males that matured at the seventh moult. Similarly, the fifth instar was 25.4 days long for males maturing at the fifth moult, 18.8 days in length for males maturing at the sixth moult, and 16.2 days long for the males that reached maturity at the seventh moult. The sixth instar was two days longer for the males that matured at this moult than for those completing one more moult before maturity. Aside from these variations related to the number of moults completed, Fig. 2 also shows that the fifth instar was longest for all the groups of males, as it was for the total number of spiderlings fed daily. Comparable differences related to the number of moults completed before maturity may be noted for the several groups of males fed maximally (Series 71 I; see Table IV); for these spiderlings the last instar was invariably the longest.

When the mean instar lengths of the males fed every other day (Series 28 I) are compared the differences are not as clear-cut. In all instances as shown in Fig. 1, the fourth instar was the longest, but it was not appreciably longer in the males maturing at the fifth moult than in those completing a greater number of moults. The greatest difference occurred in the length of the sixth instar; this was 15.9 days long for the males maturing at the sixth moult, and 10.4 days in length for the males that matured at the seventh moult.

When fed every four days (Series 19 II B) the male spiderlings matured at the sixth or the seventh moult. The greatest difference in instar length between these two groups of males occurred in the third instar; this instar was five days shorter for the males that were to complete seven moults than the mean for those that matured at the sixth moult. The later instars of these two groups showed only slight differences in length. In general, greater variation in the duration of the instars of the several groups of males occurred after a fairly rapid early development, and, conversely, when the early instars were longer the later instars were more uniform in length.

The instar lengths of the females (see Table V) do not show as great variation as those of the males. Since the seven females fed maximally (Series 71 I) all matured at the seventh moult, there is no basis of comparison for females reared at this rate of feeding. In general, for all the other series the seventh instar was somewhat shorter in females maturing at the eighth moult than for females completing seven moults, while the eighth instar was shorter when nine moults occurred. A comparison of the mean instar lengths of the total number of females fed daily that reached maturity at the eighth and the ninth moults indicates that the early instars also were shorter when nine moults were completed.

In summary, then, the pattern of development of *Latrodectus mactans* varied with the rate of feeding. With maximal feeding the last instar was always the longest, but when the spiderlings were fed at successively lower rates the period when the longest instar occurred was pushed further and further back into the earlier instars. Among the members of a series variations

in instar length were also related to the number of moults completed before maturity. This was most obvious for the several groups of males fed daily and maximally, and less so for females whose developmental period was invariably longer and for the males whose early development was retarded by minimal feeding.

TABLE V.—The mean length of the instars, in days, of the females maturing at the various moults

Series	Rate of Feeding	2nd	3rd	4th	5th	6th	7th	8th	9th
71 I	Maximal		6.0	7.3	8.7	12.1	14.1		
19 II A	Daily	14.3	10.6	14.6	16.6	10.3	12.3		
		14.0	11.4	13.0	16.5	9.7	10.5	11.7	
19 I	Daily	7.8	13.6	15.4	18.4	13.2	9.6	15.4	
		6.3	9.0	16.3	20.0	14.6	9.5	8.5	24.3
71 II	Daily	8.8	10.7	9.8	14.9	12.0	14.8	24.5	
		10.3	9.2	8.0	15.6	11.2	12.0	17.5	38.5
23 I	Daily	11.5	12.0	14.3	17.5	10.0	9.9	14.2	
		17.0	8.0	13.0	17.0	10.0	9.0	11.0	12.0
22 I	Daily	7.3	8.7	17.3	28.6	13.7	9.0	16.6	
		7.0	8.0	15.5	19.0	17.0	10.0	9.5	17.0
Total Fed Daily (Excluding 71 II):		12.0	11.5	14.1	18.3	10.5	10.0	13.3	
		8.3	8.5	12.1	19.1	14.7	9.6	9.4	19.8
28 I	Every 2 Days	14.0	15.0	25.0	22.0	10.0	13.0		
		16.5	14.6	22.6	19.4	10.5	11.2	10.4	
		17.5	13.0	23.3	17.5	10.3	11.2	9.7	13.3
19 II B	Every 4 Days	20.8	23.4	17.3	12.4	10.6	10.0	14.5	
		19.7	23.7	15.7	9.7	9.3	10.7	8.3	17.7

THE AVERAGE NUMBER OF MEALS PER INSTAR

It has long been known that the amount of food received by spiderlings during development has a profound effect on the rate of growth, and also on the length of life. This was clearly demonstrated by Bonnet (1930). He considered eleven to twelve months the normal length of the developmental period of *Dolomedes plantarius* Cl., but by regulating the amount of food he was able to shorten this period to three months and to extend it to three years. Browning (1941) has shown, further, that the rate of feeding is equally important in determining the rate of growth of *Tegenaria atrica*. The rearing experiments on *L. mactans* emphasize both these points.

In Fig. 3 the average number of meals consumed per instar by spiderlings from the several series is shown. The average number of meals for the total number of spiderlings fed daily has not been computed, but Series 19 II A, consisting of 100 individuals, is considered representative of this group. Fig. 3 shows clearly that the amount of food consumed per instar by the four groups varied widely depending on the rate of feeding. Throughout the greater part of their development the spiderlings fed minimally (Series 19 II B) required less food than any of the series fed at higher rates, while the greatest amount of food was consumed by the spiderlings fed daily.

A rough correlation between the number of meals and the length of the instars is apparent when Fig. 3 is compared with Fig. 1, giving the mean instar lengths of the series. Excluding the series fed minimally, the period of the longest instar coincided with the instar during which the greatest amount of food was consumed. This is most obvious for the spiderlings fed daily and every two days. In part this rough correlation is due to the fact that the individuals of each series ate approximately the same relative proportion of the

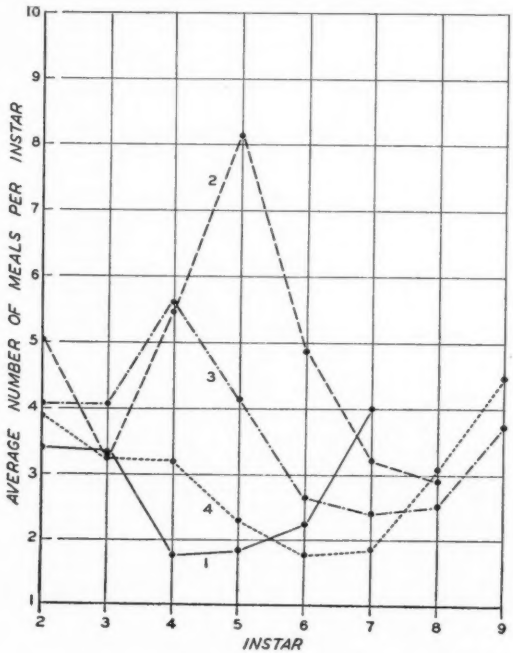

Fig. 3.—The average number of meals consumed per instar by the series of spiderlings reared at different rates of feeding. 1. Series 71 I, fed maximally; 2. Series 19 II A, fed daily; 3. Series 28 I, fed every two days; 4. Series 19 II B, fed every four days.

food offered them during each instar. The series fed daily ate from one third to one half of the meals given them per instar, while the series fed every two days ate about fifty percent of their meals. The series fed minimally consistently ate well over half of their meals, but the spiderlings fed maximally, that received approximately twice as much per meal as the other series, ate much less than half of the food given them, especially from the fourth to the sixth instars. In other words, the lower the rate of feeding the higher was the proportion of meals consumed from the total number offered per instar. The amount of food per meal is directly comparable for the series fed daily, every two days, and every four days, since the meals were of equal size for these series. Therefore, the resultant differences in the amount of food necessary for the completion of the instars were due to the rate of feeding.

The spiderlings fed maximally were able to complete the instars on a considerably smaller number of meals and in a much shorter period of time than those fed at lower rates. Since the amount of food consumed and the rate of

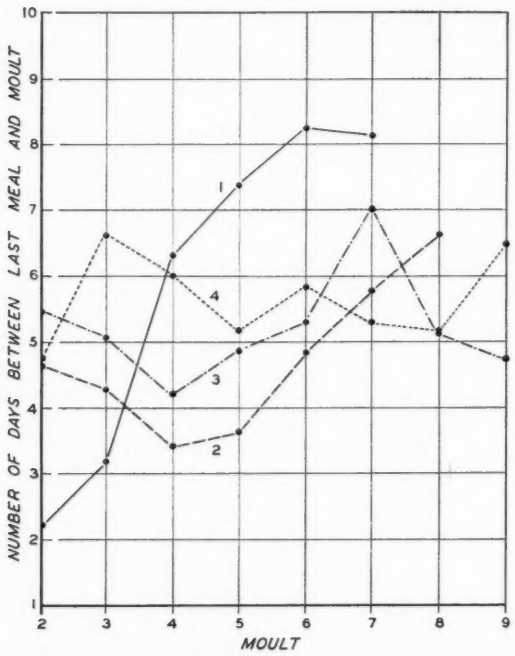

FIG. 4.—The average number of days between the last meal and the moult for each instar of the spiderlings reared at different rates of feeding. 1. Series 71 I, fed maximally; 2. Series 19 II A, fed daily; 3. Series 28 I, fed every two days; 4. Series 19 II B, fed every four days.

feeding are definitely related to the initiation of the moult it is probable, as Browning (1941) has suggested for *Tegenaria atrica*, that the moulting cycle may be controlled in a manner somewhat similar to that of insects such as *Rhodnius* (Wigglesworth, 1934). The numbers of meals consumed per instar by the several series of spiderlings indicate that the size of the meal is as important as the total amount received in regulating the relative lengths of the instars.

It is a well known fact that spiders cease to eat for a short period before the moult, the length of this interval being determined in part by the size of the spider. In *Phormictopus cancerides* (Latreille) this interval may be as long as a month, but in smaller species it is usually considered to be several days. For example, according to Smithers (1944), *Latrodectus indistinctus* fasts for two to three days prior to the moult and fifth instar *Tegenaria atrica* (Browning, 1942) cease eating four days previous to moulting. Bonnet (1930) discovered that this period may vary considerably depending on the period within the instar when food was received and the size of the meal. He also noted that spiders fed maximally after a moult ate for two to three days and then refused food for a long period until moulting occurred. Other spiders starved for ten days after the moult and then fed abundantly moulted a few hours after their last meal. Fig. 4 gives in graphical form the average number of days between the last meal and the moult for each instar of the four series shown in Fig. 3. When Figs. 3 and 4 are compared it is evident, at least to a certain extent, that the length of this period was in inverse proportion to the number of meals consumed, that is, the greater the number of meals the shorter the period before the moult during which the spiders refused to eat, and vice versa. The curves for the spiders fed maximally, daily, and every two days show this relation most clearly, while the figures for the series fed minimally are most diverse.

The amount of food necessary for the completion of an instar varied with the rate of feeding, the threshold amount being consistently less throughout the greater part of development under conditions of minimal feeding. More food per meal resulted in fewer meals and shorter instars. The length of the period of fasting before the moult increased with maximal feeding, and decreased when a greater number of meals were consumed before the initiation of the moult.

THE NUMBER OF INSTARS

The variation in the number of instars completed during development is shown in Table VI, which gives the numbers of spiderlings maturing at the various moults at different rates of feeding. With maximal feeding the males completed four to six moults, the greater number finishing their development at the fifth moult. The range for the total number of males fed daily was from five to seven moults, with the majority maturing at the seventh moult. When fed every other day the males moulted five to seven and in one instance eight times. For this series also the majority moulted seven times. The males fed every four days had six or seven instars, the greater number becoming mature at the sixth moult.

The females fed maximally matured at the seventh moult, but the series fed daily required seven to nine moults for their development. The great majority of the females underwent eight moults, although the range was from seven to nine for the spiders fed every other day, and eight to nine when fed every four days.

In Fig. 5 the percentage of moults completed by the total number of mature spiders of the several series is shown in graphical form. The spiderlings that died before maturity are not included in these figures. It is apparent that the spiderlings fed maximally required fewer instars for the completion of their development. This general rule that spiders developing under optimal conditions attain maturity after a smaller number of moults has been noted by a number of investigators, especially by Bonnet (1930) for *Dolomedes plantarius*. The series fed daily and every other day exhibited a comparable moult range, although relatively more males matured at the seventh moult in the series receiving less food. When fed every four days, no male reached maturity before the sixth moult, but the percentage of individuals completing the eighth and ninth moult was almost identical with that of the series fed every other day. In other words, the range of moults was less for the spiderlings receiving the maximal and minimal amounts of food, and greater for the spiderlings fed daily and every other day. The latter series formed the intermediate stages between the other two series. The environmental conditions can, therefore, have a considerable effect on the number of instars necessary for the development of *Latrodectus mactans*. Inherent factors must limit the possible number of moults. A total of six to nine moults has been recorded for females, while the recorded range for males is even greater, from three (Herms, Bailey, and McIvor, 1935) to eight. It is extremely improbable that a male could attain maturity in less than three moults; in fact, three would seem insufficient for the necessary development attendant on maturity, since it implies only two moults after the emergence from the egg cocoon. However, nine is presumably the maximum number of moults for females, no more than this having ever been observed. This range in the number of instars com-

TABLE VI.—Numbers of spiderlings maturing at various moults at different rates of feeding

	Males Number of Moults					Females Number of Moults		
Rate of Feeding	4	5	6	7	8	7	8	9
Maximal	2	6	1			7		
Daily		20	65	84		8	81	12
Every 2 days		8	9	33	1	1	26	4
Every 4 days			29	10			21	3
Totals	2	34	104	127	1	16	128	19

pleted during development indicates a considerable adaptability to varying environmental conditions.

The range of moults reported for other species of *Latrodectus* is not so wide. According to Shulov (1940), the females of *L. pallidus* moult six to seven times, the males four to five times, while the females of *L. tredecimguttatus* complete eight moults, the males five to six. The females of *L. indistinctus* (Smithers, 1944) also moult eight times, but the range for the male is from four to six. Bonnet (1938b) recorded seven instars for females and five for males of *L. geometricus*. Possibly if raised under varying conditions these species would show a wider range in number of moults.

AGE AT MATURITY

Inevitably, the age at maturity varied with the length and the number of the instars. The youngest males were the two from the series fed maximally that matured at the fourth moult in an average of 25.5 days, while the oldest male reached maturity 103 days after emergence from the egg cocoon and after completing eight moults. The average age of the females at maturity

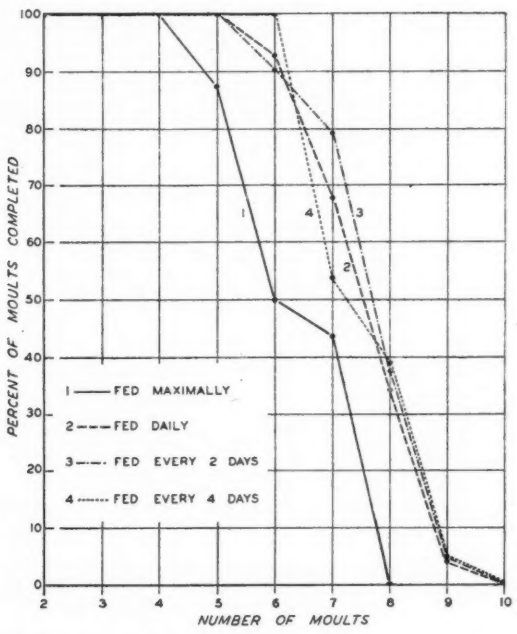

Fig. 5.—The percentage of moults completed by the total number of adult spiders reared at different rates of feeding.

ranged from 56.7 days for the females fed maximally maturing at the seventh moult to 121.6 days for the females completing nine moults from Series 71 II, whose later development was abnormally slow. The average age at maturity, in days after emergence from the egg cocoon, of the males and females of the several series maturing at the various moults is given in Table VII, while Fig. 6 presents these data in graphical form, Series 19 II A representing the group fed daily. The majority of the males were 65 to 95 days old at maturity, while the females were approximately 80 to 110 days old. The males of the series fed every two days and those fed every four days that matured at the sixth and the seventh moult were closely similar in age, those maturing at the sixth moult averaging 90.5 days, and those maturing at the seventh moult being approximately 95 days old. However, the females of the series receiving

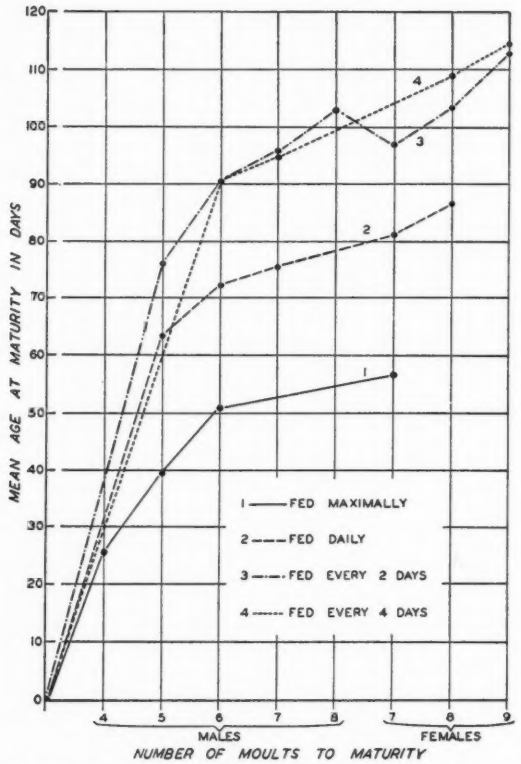

Fig. 6.—The mean age, in days after emergence from the egg cocoon, of male and female spiders reared at different rates of feeding and maturing at various moults. Series 19 II A represents the group fed daily.

the least food were a few days older at maturity than those of the series fed every two days. As a rule three to four months were required for the development of the females, while the males reached maturity in two to three months, excluding the period spent in the egg cocoon. The dates on which the cocoons were made and on which the spiderlings emerged are given in Table I for all the series except Series 71 I.

After emergence from the egg cocoon, the length of the developmental period of one brood of *Latrodectus tredecimguttatus* (Shulov, 1940) varied from 99 to 190 days for females, although the males averaged 96 days. From another brood the females averaged 253 and the males 203 days. The length of the period spent in the cocoon varied from 41 to 193 days, depending on the time of year when the eggs were laid. Females of *L. indistinctus* (Smithers, 1944) required three to four months for their development in the field, but the males reached maturity 38 to 42 days after emerging from the egg cocoon. The wide variations recorded for *L. tredecimguttatus* in particular are apparently due largely to temperature.

THE SEX RATIO

The total numbers of males and females for each series are given in Table VIII. Of the 494 spiders whose sex is known, 56.3% were males and 43.7%

TABLE VII.—Age at maturity, in days after emergence from the egg cocoon, of the males and females maturing at various moults

Series	4th	5th	6th	7th	8th	9th
MALES:						
71 I	25.5	39.6	51.0			
19 II A		63.4	72.2	75.5		
19 I		64.3	75.5	80.6		
71 II		48.0	66.2	77.4		
23 I			72.7	78.5		
22 I		70.0	82.0	88.3		
28 I		75.9	90.4	95.7	103.0	
19 II B			90.6	94.7		
FEMALES:						
71 I				56.7		
19 II A				81.3	86.7	
19 I					93.2	110.3
71 II				77.5	95.5	121.6
23 I					85.6	97.0
22 I					102.1	105.0
28 I				97.0	103.5	112.7
19 II B					109.0	114.6

were females. This is an unexpectedly large proportion of females for a spider such as *Latrodectus*. According to Bonnet (1938a), the sex ratio is dependent on the relative size of the sexes and their behavior at mating, and on this basis he distinguished three categories: (1). When the sex ratio is equal, the males and females are of the same size and complete the same number of moults or possibly the females may undergo one more moult than the males. (2). When males constitute 61 to 84% of the total, they are clearly smaller than the females and complete fewer moults. As examples, Bonnet cited *Nephila*, whose males are decidedly smaller than the females, and *Tegenaria* and *Filistata* in which the proportion of males is high although the size of the two sexes is similar. Bonnet also believed that more males were found when there is a greater chance that they may be eaten at mating, as in *Dolomedes, Pirata, Latrodectus*, and *Nephila*. (3). In the third category Bonnet included those forms, such as *Pholcus phalangioides, Amaurobius erberi*, and *Araneus diadematus*, for which he had found that the number of moults was the same but more females than males were observed. However, he raised few individuals of these species to maturity. In these species the male is never eaten at mating.

Latrodectus mactans definitely belongs in Bonnet's second category, although the percentage of males is not so high as the figures given by Bonnet. The numbers of the sexes given in Table VIII show that the relative percentage of females and males may vary considerably.

The question of the effect of the amount of food received during development on the sex ratio has also been raised. Bonnet (1938a) concluded that females survive better than males on little food, and that the sex ratio is modified only by the deaths of the immature males. This is not fully corroborated by *L. mactans*, since the total number of males was proportionately higher (61.1%) in the series receiving the least food than in the majority of the other series. On the other hand, in the series fed every two days, the ratio was nearly equal (51.9%), and in one instance (Series 23 I; see Table VIII) males constituted only 41.8% of the total number. Actually, it appears that in *L. mactans*, at least under experimental conditions, both sexes have an equal chance of survival.

Misconceptions concerning the sex ratio of *L. mactans* resulted from Montgomery's (1908) work. He claimed that the sex of the newly emerged spiderlings could be distinguished by the form of the abdomen and the insertion of the pedicel, and on this basis reported a ratio of eight males to one female. None of the spiderlings were raised to test this theory. He also believed that he could differentiate the sex of the eggs of *Theridion tepidariorum* on the basis of varying size. Bonnet (1934) examined the eggs from 41 cocoons of the latter species and found no size differences; he (1938b) also raised twenty *Latrodectus geometricus* to maturity. He concluded that it is impossible to differentiate the sex of the eggs or the young spiderlings. Smithers (1944) was unable to determine any sexual differences among young spiderlings of *L. indistinctus*. No species is known whose sexes can be determined early in development.

SURVIVAL DURING DEVELOPMENT

From the total of 633 spiderlings, 430 reached maturity, 35 were killed for experimental purposes, 166 died before completing their development, and 4 escaped during the early instars. Of those not reaching maturity, 139 died before their sex could be determined, leaving a total of 494 whose sex is known. Expressed as percentages, 67.9% completed development, while 32.1% died, escaped, or were killed; the sex could be determined for 78% of the total number, leaving 22% of unknown sex. Since the swelling of the male pedipalps is obvious one moult before maturity, and since the males complete a smaller number of moults, all the spiders that were not unquestionably males at the sixth moult have been considered females. The numbers of males and females from the various series are given in Table VIII.

The percent of the total number surviving each instar of the several series is shown in graphical form in Fig. 7. From this it is apparent that mortality was highest, especially during early development, for the series receiving the least food. Fewer spiderlings died from the series fed maximally, while there was a small but constant mortality during the development of the spiders fed daily. The causes of death during development have already been discussed (Deevey and Deevey, 1945), and nothing can be added to our original statements. More than half of the deaths were related to the moult, since deaths after maturity are not pertinent to these considerations. Approximately half of these deaths were due to failure to complete the moult in perfect condition; this occurred most frequently during the early stages. The other deaths related to the moult were caused by mealworms eating the spiders when they were helpless to defend themselves. The great majority of the deaths during later development were due to this. For example, in Fig. 7 the sudden increase in mortality after the seventh moult in the series fed every two days was due entirely to mealworms. Little can be said about the many baffling instances

TABLE VIII.—Survival of the spiderlings during development

Series	Total No. Spiders	No. Dead Before 6th M.	Total No. Males	Total No. Females	No. Adult Males	No. Adult Females
71 I	17	1	9	7	9	7
19 II A	100	15	45	40	45	35
19 I	25	3	14	8	14	8
22 I	29	2	17	10	17	9
71 II	160	45	73	42	71	31
23 I	86	31	23	32	22	18
28 I	108	6	53	49	51	31
19 II B	108	36	44	28	38	24
Totals	633	139	278	216	267	163

when death occurred during the instars for no externally apparent reason, although it is highly probable that the relatively high death rate observed during the early development of the spiderlings fed minimally (see Fig. 7) was at least in part due to insufficient food.

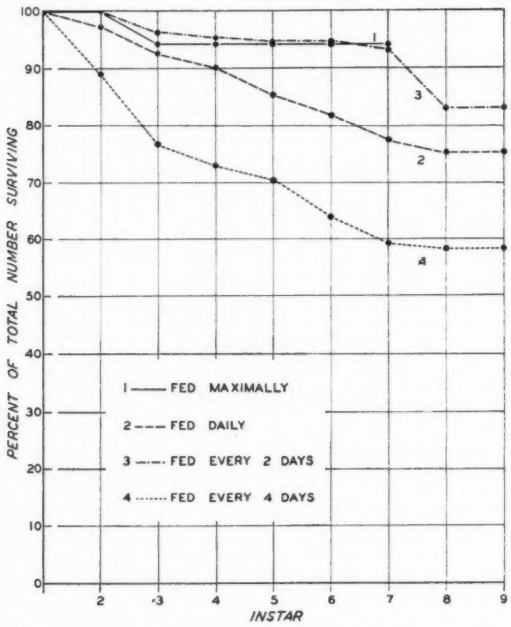

Fig. 7.—The percentage of the total number surviving each instar when reared at different rates of feeding.

THE LIFE SPAN OF THE MALE

Male and female longevity has already been discussed (Deevey and Deevey, 1945) for the members of the two series, 71 I and 71 II, that were allowed to die a "natural" death. Due to the much greater life span of the females, it was not feasible to maintain them as adults and therefore the females of the other series were killed. The males, however, have a much shorter life, the majority becoming moribund four to five weeks after attaining maturity. The adult males almost invariably refused to eat, at least under laboratory conditions, although food was always available to them. Shulov (1940) also noted that the adult males of *L. tredecimguttatus* only rarely caught prey. Because of their shorter life span, the total length of life of 155 males is known. This figure includes only the males that were senescent before death. Table IX

gives the average length of life of the males after maturity had been reached, and it is apparent that regardless of the number of instars completed during development the length of time lived as an adult is similar for all the series. The range of adult male life was from 20 to 62 days, but few spiders lived for more than 40 days. The males of *L. tredecimguttatus* also live but a short while, from 40 to 50 days according to Shulov.

However, the total life span of males fed at different rates and maturing after a varied number of instars showed a considerable range. The average total life span, in days, of males from the several series maturing at various moults is given in Table X. As Bonnet (1930) has reported, the spiders developing at a faster rate have a shorter life span, while those whose development is retarded live for a longer period. Unfortunately, it was impossible to allow the males from the series receiving the least food (Series 19 II B) to die a "natural" death, but it is probable that their life span would have been similar to that of the spiders fed every two days (Series 28 I), since they matured at the same age. The age at death ranged from 58 days for a male from Series 71 I that completed its development in four moults to 160 days for a male from Series 71 II that matured at the seventh moult. This latter spider was nine days older at death than the one previously mentioned as living 62 days as an adult male. When the figures for all the series fed daily are averaged (see Table X), the life span of the males maturing at the various moults is fairly similar, although as a rule the males completing the greater number of moults lived a few days longer than their brothers. It is possible that the greater variation in age noted in the spiders fed maximally (Series 71 I) and every two days (Series 28 I) may be due to the much smaller number of individuals involved. The life spans of eight males are included in Series 71 I, and of 15 males in Series 28 I, while a total of 134 males comprise the group fed daily. Despite this discrepancy in the numbers of the several groups, the figures obtained are probably sufficiently representative of the life spans of males developing at these several rates to be acceptable. The

TABLE IX.—Average length of life of male as adult, in days

Series	4 Moults	5 Moults	6 Moults	7 Moults	Total Average
71 I	33.5	34.3	29		33.5
19 II A		33.2	35.6	34.6	35.2
22 I		36.5	49	40	37.8
23 I			28	33.5	33.0
71 II		34	30.8	33.0	32.8
19 I		38.3	38.6	32.5	37.5
28 I		38.6	34.2	36.8	36.8
Total Average					34.5

figures given in Table X give the age in days after emergence from the cocoon, and therefore a month must be added to obtain the total length of life from the time the eggs were laid. (See Table I for the exact length of the period in the egg cocoon.)

TABLE X.—Average total life span of males, in days after emergence from the egg cocoon

Series	Rate of Feeding	4 Moults	5 Moults	6 Moults	7 Moults
71 I	Maximally	59.0	68.4	80.0	
19 II A	Daily		96.6	106.6	103.0
23 I	Daily			115.0	111.6
19 I	Daily		103.0	111.4	113.0
22 I	Daily		108.6	131.0	124.0
72 II	Daily		82.0	93.0	109.3
Total Fed	Daily		103.1	106.2	108.4
28 I	Every 2 Days		115.0	120.0	131.0

Females may live 1½ years or more. The oldest female from Series 71 II died at the age of 549 days, excluding the month in the egg cocoon. It is improbable that the number of moults completed during development are important in shortening or lengthening the life span of females. A similar total life span has been recorded for the females of *L. tredecimguttatus* (Shulov, 1940) and *L. indistinctus* (Smithers, 1944).

DISCUSSION

Aside from the work by Browning (1941) and Jones (1941), rearing experiments on araneids have been confined largely to the isolation and unrecorded feeding of spiderlings, with observations on their development. By far the greatest amount of work on this subject has been done by Bonnet, who has raised individuals of many species to maturity. In most instances small numbers of each species were studied, but more extensive observations were made on *Nephila madagascariensis* and especially *Dolomedes plantarius*. From his experiments Bonnet (1930) found that it was possible to accelerate or retard the growth of *Dolomedes* by varying the amount of food. He concluded, in part, that the length of the developmental period and the longevity of a species were dependent on the temperature and the amount of food received, and that the number of moults may vary depending on the size of the species, on the individual, and on the sex. He noted, also, that the instar length did not necessarily increase with age, but was related to the amount of food and the temperature. In short, environmental factors exerted a profound influence throughout development. These general conclusions apply to *Latrodectus mactans*.

Table XI gives the number of moults recorded during the development of a number of species of Araneida. This is not an exhaustive list, but provides an indication of the range in number of moults observed for various species. With regard to the relation between the size of the species and the number of moults, Bonnet (1930) concluded that small spiders such as *Pholcus phalangioides* and *Uloborus plumipes*, measuring 5-7 mm., moult 4 or 5 times, medium-sized species such as *Lycosa ruricola* and *Epeira diadematа*, measuring 8-11 mm., moult 7 to 8 times, while large forms like *Dolomedes plantarius* and *Tegenaria parietina*, 15-30 mm. in size, complete 10 to 13 moults. A proportionately larger number of moults are completed by extremely large species such as *Eurypelma californica*. Bonnet (1933b) found that there is also a relation between the size of the egg and of the adult, since an unusually small species, *Lessertia dentichelis*, approximately one-half the size of *Pholcus*, moulted five times during its development. *Latrodectus mactans* exemplifies the fact that it is impossible to place certain species in definite categories, since although the female fits in Bonnet's medium-sized group, the male is more variable. A similar wide range of moults has been recorded for the male of

TABLE XI.—Number of moults completed during the development of various araneids (Data in part from Bonnet, 1930, table XXI)

Species	Males	Females	Author
Dolomedes plantarius	9–11	9–13	Bonnet, 1930
Epeira diadematа	6–7	7–8	Bonnet, 1930
Lycosa ruricola	6–7	7–8	Bonnet, 1930
Zoropsis spinimanus	8–9	8–9	Bonnet, 1930
Pirata piraticus	6–8	7–8	Bonnet, 1930
Amaurobius erberi	6–7	6–9	Bonnet, 1930
Pholcus phalangioides	5	4–5	Bonnet, 1930
Tegenaria parietina	9, 10, 12	10–11	Bonnet, 1930
Tegenaria agrestis	9	9	Bonnet, 1930
Nephila madagascariensis	4–6	9–12	Bonnet, 1930
Nephila madagascariensis	5–9	11	Gerhardt, 1929
Physocyclus simoni	5	5	Bonnet, 1937
Philaeus chrysops	7–8	8–9	Bonnet, 1933a
Uloborus plumipes	5	5	Berland, J., 1914
Dolomedes fimbriatus	9–10	9–10	Bonnet, 1926
Theridion tepidariorum	6–7	7	Bonnet, 1935
Misumena vatia	6	6	Gabritschevsky, 1927
Misumena aleatoria	6	6	Gabritschevsky, 1927
Heteropoda regia	10–11	10–11	Bonnet, 1932
Lessertia dentichelis	5	5	Bonnet, 1933b
Eurypelma californica	22	?	Baerg, 1928

Nephila madagascariensis (see Table XI). Possibly the number of moults varies more widely in species such as *L. mactans* that are known to live under diverse ecological conditions.

Browning's (1941) controlled experiments on third, fourth, and fifth instar *Tegenaria atrica* showed more clearly the effects of various environmental factors on the instar length of this species. High temperature, high humidity, and illumination shortened the instars. A rise of 10° C. (from 20° to 30° C.) approximately halved the mean instar length. A threshold amount of food was found necessary for the completion of an instar, this quantity being greater when the rate of feeding was lower, although excess food did not affect the length of the instar. Minimum food resulted in a slightly longer instar, but with excess food the succeeding instar was shorter. Browning concluded that instar length can be affected by the environment in several ways: through the materials necessary for metabolism, by physico-chemical action on the metabolism, or through the mechanism which activates the moulting cycle. In the first category he included water, food, and age, in the second temperature, humidity, light, and inherited factors, while the third category included any of these factors.

The number of meals per instar consumed by the several series of *Latrodectus mactans* (see Fig. 3) also indicated that a threshold amount of food was required before the ensuing moult could occur, and that the total amount consumed varied considerably depending on the rate of feeding. That the size of the meal was also important was shown by the much more rapid development of the spiders fed maximally (Series 71 I). At a lower rate of feeding the threshold quantity was much greater, especially for fourth and fifth instar *L. mactans* of the series fed daily and every other day. The series fed minimally, however, completed the greater part of their development on a lower threshold amount of food than was necessary for all the other series. The earliest instars of these spiderlings were lengthened by minimal feeding, but their fifth to seventh instars were shorter than for the majority of the other series. Browning's spiderlings that received minimal food in the fourth instar were given excess food in the fifth, while the *L. mactans* fed minimally received food at the same rate throughout development. The results obtained with *L. mactans* are comparable, however, since once past the third moult the ensuing instars up to and including the seventh were successively of shorter duration. To explain the shortening of an instar following one lengthened by minimal feeding Browning suggested that at a low feeding rate spiders might retain nitrogenous products usually lost in the faeces. With their excretory mechanisms adapted to minimal feeding, a smaller total quantity of food would be necessary to provide the nitrogenous constituents for the new chitin, and therefore the succeeding instar would be shortened. Since Browning did not raise *Tegenaria atrica* to maturity, we do not know whether the later instars would have reacted differently to the several environmental factors or what effetcs these factors would have on the total life span, the number of instars, and the age at maturity. At the sixth instar it was still impossible to determine the sex.

Jones's (1941) study on the effects of temperature and humidity on the development of *Agelena naevia* Walckenaer showed that more spiderlings survived when the temperature was constant at 27° C. with a relative humidity of 92%. Death occurred during the second instar if the relative humidity was 50% or less, although exposure to a relative humidity slightly over 50% for a short period each day allowed further growth. The majority of the spiderlings died by the fifth instar, and none survived the sixth. The reason for this was not apparent. Instar length was shortest at 27° C., though a little shorter when the temperature varied slightly around 27° C. than when it was constant. Humidity had less effect on instar length than on mortality.

It is obvious that environmental factors may mold the growth of araneids in a variety of ways, while the degree to which the development may be modified is dependent on the inherent plasticity of the species and the individual. Genetic factors determine the range of variation of the environmental conditions that are compatible with the continued growth and reproduction of the species, and they must likewise have an influence on the survival and rate of development of individuals within a species. Browning (1941) reported that for fifth instar *Tegenaria atrica* from three parentage groups the instar length of any individual differed significantly from any member of the other groups but not from members of the same group. He therefore concluded that inherited factors, as well as environmental conditions, affect instar length. The data obtained from the black widow are not as suitable for an analysis of this sort and so none has been made. A comparison of the mean instar lengths of the several series, given in Table III and illustrated in graphical form in Fig. 1, leads only to the obvious conclusion that environmental conditions are more important in determining instar length. However, the variations noted between the series fed daily that received the same treatment and between the individuals of a series may be due, as Browning has suggested, to genetic factors controlling growth rate. An analysis of the coefficients of variation (the standard deviation expressed as a percentage of the mean instar length) for the various series and for the groups of males and females constituting the series proved most confusing. In general the highest percentages were obtained for the fourth to sixth instars of all the series. When the series were broken down to their component groups of males and females, the coefficients of variation were lower, in a few instances less than 5.0% for some instars. In every group of males or females at least one instar showed high variability, and for all the series the coefficients of variation were greater for the series fed at lower rates. For example, the highest percentage obtained for any of the group fed maximally (Series 71 I) was 19% for fourth instar females, while for Series 19 II A, fed daily, the highest figure recorded was 24% for the sixth instar of the females that matured at the seventh moult. On the other hand, the coefficient of variation for the third instar of the same females fed maximally was 1%, and for the same females fed daily it was 11.7%. Therefore, under more optimal conditions of feeding inherent variation was less apparent, but when raised under less optimal conditions the instar lengths of a group varied more widely depending on individual reactions to external conditions. In summary,

variations in the length of the instars of *Latrodectus mactans* are due: (1) to the rate of feeding, and presumably other environmental factors, especially the temperature; (2) to the varying number of instars completed during development by the individuals of a series; (3) to the genetic constitution of the individuals, which finds expression in varying growth rates under identical conditions.

The problem of the variation in the number of instars is related to the length of the instars. This relationship is obvious when the instar lengths of the males reared at the higher feeding rates (see Fig. 2) are considered. When the fourth and fifth instars were longer, maturity was attained after a smaller number of moults, and conversely shorter instars resulted in a greater number of moults. It is apparent that the stimulus which produces the maturity moult is different from the ordinary moulting stimulus. In males this stimulus which brings about the conclusion of development acts at least one moult before maturity, as is evidenced by the swelling of the male pedipalps. The females also showed a similar relationship between the length and the number of the instars, since eight moults occurred when the seventh instar was shorter and nine moults were completed when the eighth instar was short. Since the factors which produce the maturity stimulus are at present unknown, it is impossible to do more than to note the existence of this relationship between the length and the number of instars. Presumably there is some underlying relationship, which cannot now be discussed further, among factors governing rate of growth in size, rate of onset of sexual maturity, and variations in these rates within particular instars.

Because of the range of variability encountered both in the length and the number of the instars completed during the development of *Latrodectus mactans* reared under similar conditions, it would be possible to predict only approximately the length of any given instar of an individual reared at a definite rate of feeding. A much fuller knowledge of the factors involved in the growth and development of araneids must be obtained before accurate predictions of instar length may be made.

SUMMARY

Spiderlings of *Latrodectus mactans* were reared at several rates of feeding: one series fed once every four days, one series fed once every two days, several series fed once daily, and one series fed once daily but twice as much per meal as the other series received. This latter rate of feeding was termed maximal.

When reared at these several rates of feeding, variations both in the length and in the number of instars occurred. Variations in instar length were of three types: (1) those due to the rate of feeding; (2) those due to the number of instars completed before maturity by the males and females comprising a single series; (3) those due to individual variations in growth rate, presumably the result of inherited factors.

Distinctive patterns of development resulted from the several rates of feeding, as shown by the period of occurrence of the longest instar. With maximal

feeding, the last instar was invariably the longest, but at the lower feeding rates the longest instar occurred at progressively earlier periods. Thus, when fed daily the fifth instar was the longest, and when fed every two days and every four days the fourth and third instars, respectively, were longest. After the fifth moult the instar lengths of all the series were fairly similar, despite varying rates of feeding.

Within a series, variations in instar length were related to the number of moults completed before maturity by the several groups of males and females; this was most apparent in the males of the series reared at the higher feeding rates, and less so for the series whose early instars were of longer duration, due to poorer feeding.

The amount of food necessary for the completion of an instar also varied with the rate of feeding, the threshold amount being least for the spiderlings fed every four days and greatest for those fed daily. More food per meal resulted in fewer meals and shorter instars. The length of the period of fasting before the moult was in inverse proportion to the number of meals consumed during an instar.

The number of instars completed during development varied with the rate of feeding, fewer instars resulting from maximal feeding. The range in number of moults completed was least for spiderlings reared under conditions of maximal and minimal feeding, and greater for the series fed daily and every two days. Three to eight moults have been recorded for males, and six to nine for females.

The problem of the variation in the number of instars is related to the length of the instars. This was most apparent in the males reared at higher feeding rates. Longer instars resulted in a smaller number of instars, and conversely when the instars were shorter a greater number of moults were completed before maturity.

The age at maturity was dependent on the length and the number of the instars. Excluding the month in the egg cocoon, the range in mean ages at maturity recorded from all the series was from 25.5 to 103 days for males, and 56.7 to 121.6 days for females.

The sex ratio obtained from 494 spiders was 56.3% males and 43.7% females. Under laboratory conditions, males and females appeared to have an equal chance of survival.

Of 633 spiderlings, 67.9% reached maturity and 32.1% died, escaped, or were killed for experimental purposes. 78% survived the first six instars. Mortality was highest for the series fed minimally. More than half of the deaths during development were related to the moult.

The adult life of the males was of similar length despite the varying number of moults completed before maturity, the total average being 34.5 days. The total life span of the males was dependent on the rate of feeding and the number of instars. Excluding the month in the egg cocoon, the age at

death ranged from 58 to 160 days. The longest total span recorded for females was 549 days, excluding the period spent in the egg cocoon.

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A Preliminary Ecological Study on Certain Deciduous Forest Centipedes[1]

Stanley I. Auerbach

Northwestern University, Evanston, Illinois

and

University of Illinois, Urbana

Introduction

In February, 1946, the writer began a study of the chilopod population in Trelease and Brownfield Woods, belonging to the University of Illinois. These are two deciduous forest areas in which red oak, maple, and elm are prominent, located about five miles northeast of Urbana, Illinois. This undertaking was aided by the use of chilopod population data, based on quantitative collections made in Trelease Woods by the Department of Zoology and the Graduate School over a period of about thirteen years. Within the time available an attempt was made to determine whether there were any differences in the reactions of the different species of centipedes to various environmental factors. The life-histories and taxonomy of the chilopods of these forest areas were also investigated with a view to learn something of their importance in the community.

Laboratory Equipment

Chilopods were brought into the laboratory. Keeping them in cultures of soil and decayed wood proved to be unsatisfactory for observation and other methods were tried. In all the methods the basic container was a side-arm test tube 145 x 20 mm. (Fig. 1). In it were placed fragments of mica to provide ample contact surfaces for the animals. The tube was put into a glass insect cage with a metal tank bottom (Fig. 2). This cage was equipped with two glass culture dishes, filled with water. By this method the relative humidity was held at approximately 60 per cent. The first group of animals was kept in a glass-roofed room where the temperature during March, 1946, reached 38°C. After two days of these high temperatures all seven centipedes died. The apparatus was moved to a basement laboratory, where the temperature never varied more than a few degrees from 20°C. Seventeen animals were placed in the bottom of the cage. All of the animals died within a week.

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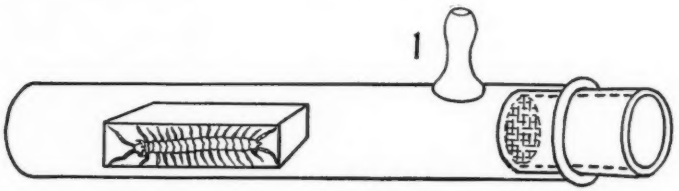
1 The writer thanks Professor V. E. Shelford of the University of Illinois, who inspired and guided this study. The writer is indebted to Professor Orlando Park of Northwestern University for aid and to Professor R. V. Chamberlin of the University of Utah, who checked the identifications.

It was concluded that a much higher humidity was necessary to maintain the animals under semi-sterile conditions. Accordingly, the cage was modified (Fig. 2). A sheet of half-inch mesh screening was laid across the top of a metal tank to support the culture tubes, and the tank was filled with water.



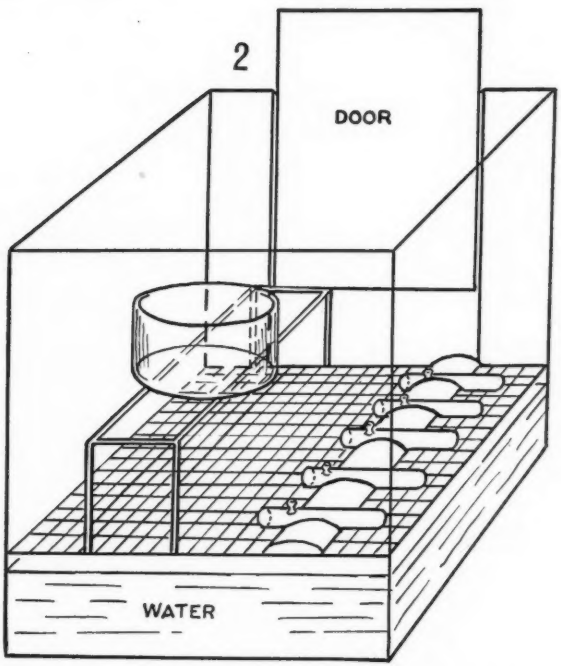


Fig. 1.—The basic container for the centipedes was this standard side-arm test tube 145 x 20 mm. Inside it was a block of water-soaked cypress, 40 x 9 x 9 mm., which provided a resting place and also helped to maintain a high humidity.

Fig. 2.—Glass insect cage with a metal tank bottom filled with water. Mesh screening was placed across the top of the tank to support the tubes. Above them, on wire supports, a dish of water was placed.

The side-arm test tubes rested in supports made of modeling clay. A dish of water was placed above the tubes. Inside each tube were one or two blocks of thoroughly water-soaked cypress, each block 40 x 9 x 9 mm. These provided a place on which the centipede could rest (Fig. 1), and also helped to maintain a high humidity. This apparatus was checked with a direct-reading hygrometer and indicated a relative humidity of almost 100 per cent. The apparatus proved to be successful for keeping the animals in good condition. They lived in it with no apparent ill effects, and with few deaths over a period of three months.

LABORATORY EXPERIMENTS

Centipedes in the laboratory were subjected to gradients of relative humidity. The apparatus for the control of humidity has been described by Shelford (1929). The circular gradient cage designed by Johnson (1926) and described by Shelford (1929), (A of Fig. 3), was used instead of the linear gradient (B of Fig. 3). Animals moving back and forth in a linear gradient hesitate at each end and frequently move across the container when coming in contact with the end wall. This tends to cause reactions at the ends and corners to factors other than the air.

The cage (A of Fig. 3) had screens around the side to confine the animals, and diffuse the air currents. A tight-fitting glass cover was placed over the top of the dish. Four streams of air, of different humidities, were introduced by four pipes into the center of the circular cage and the air blown radially. One stream was of high relative humidity (approx. 90%), two of intermediate relative humidity (approx. 60%), and one of low relative humidity (approx. 40%). The same cage was used subsequently for a control. In the control experiment, the animals' movements were graphed without any air flowing into the cage. The room relative humidity during this time ranged from 66-71%. (See description of figures.)

The movements of the animals under experimental and control conditions are given in graph form (Figs. 3, 4, 5). The distance from left to right between the different scales represents the areas of different humidities. The vertical scales are time scales, with minutes divided into ten-second intervals. In tracing the movements of the animals the pencil was moved down with the passage of time, and to the right or left as the animal moved.

The centipedes used for this experiment were *Bothropolys multidentatus* (Newport), *Otocryptops sexspinosus* (Say), and *Neolithobius voracior* (Chamberlin). Four experiments were performed with each species. Each test lasted twenty minutes and was plotted in two ten-minute columns. The three figures (Figs. 3, 4, 5) show the typical behavior pattern of these centipedes.

The animals were placed in the apparatus while it was inoperative and given ten minutes to recover from any reactions to handling. In the case of *B. multidentatus* (Newport), (Fig. 3), after the air was turned on the

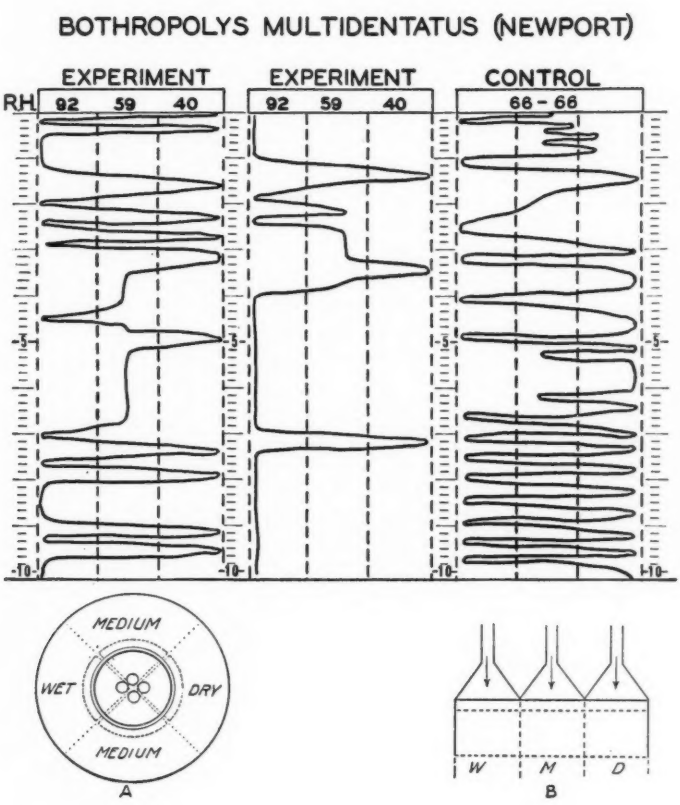


Fig. 3.—Graph showing the typical behavior of *Bothropolys multidentatus* (Newport). Below to clarify the use of the experimental cages is *A*. a diagram of the circular gradient cage used. It is essentially similar to the linear gradient represented by *B*. shown below the control graph. The rectangular container is drawn to the scale of the graph. The round container A was used and graphed with the line turning back from the dry, e.g. when the animal actually passed through the dry into the second medium, etc. The fact that in going around the pan once the animal passes twice through the medium air and once through the wet and through the dry is compensated for by the use of the time scale. A time piece with large second hand is used.

Typical behavior pattern of *B. multidentatus* (Newport) under experimental and control conditions. The distance from left to right between the different scales represents the areas of different humidities. The vertical scales are time scales, with minutes divided into ten-second intervals.

animal responded immediately, moving about the cage. It kept circling the gradient, stopping for increasingly longer periods of time in the moist zone, until it finally stopped completely in this area. In the control the animal spent the greater portion of the ten-minute period circling the cage.

As a check on the validity of these visual interpretations, the time spent in each portion of the gradient by four animals was totaled and converted to percentages. For *B. multidentatus* (Newport) 47% of the total experimental time was spent in the moist portion of the gradient. 31% was spent in the intermediate area, and only 21% in the dry zone.

The typical movements of *N. voracior* (Chamberlin) are shown by Figure 4. The procedure was the same as before. When the apparatus was operative the animal moved over to the moist area and remained there for a short time. Then it began a series of what appeared to be exploratory trips around the gradient. During these movements the strongest response appeared to be directed toward the intermediate zone.

The time totals on four experimental animals of this species also indicated this response to the intermediate zone. In percentage terms, 34% of the total

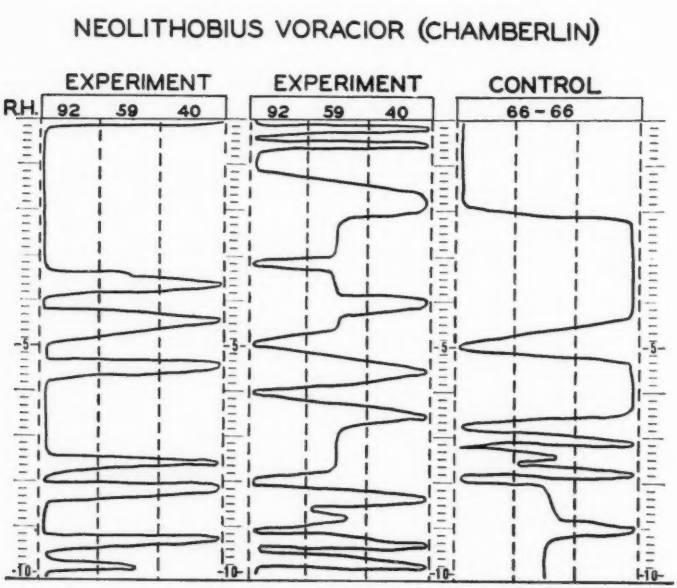


Fig. 4.—Graph showing the typical behavior pattern of *N. voracior* (Chamberlin).

time was spent in the moist zone, 50% in the intermediate zone, and only 15% in the dry zone.

Figure 5 shows the typical behavior of *O. sexspinosus* (Say), a blind scolopendrid centipede. In this particular case, after the air was turned on the animal responded immediately, moving about the cage. For a time it remained in the intermediate zone, touching the sides and top of the cage with its antennae. It finally stopped in the moist area. In the control experiment, the animal circled the cage a few times and finally settled in what had been the dry portion of the gradient. This is undoubtedly a thigmotactic reaction which can be overcome by changing the relative humidity. In percentage terms, four experimental animals spent 42% of the total time in the moist area; 42% in the intermediate area; and only 14% in the dry area.

BIOLOGY

Twelve species of chilopods are found in Brownfield and Trelease Woods. Of these, *Bothropolys multidentatus* (Newport) is by far the most numerous, with the possible exception of *Poaphilus kewinus* Chamberlin, which is a minute, soil-inhabiting geophilid. *Neolithobius voracior* (Chamberlin) was taken only once in quantity during the period of study.

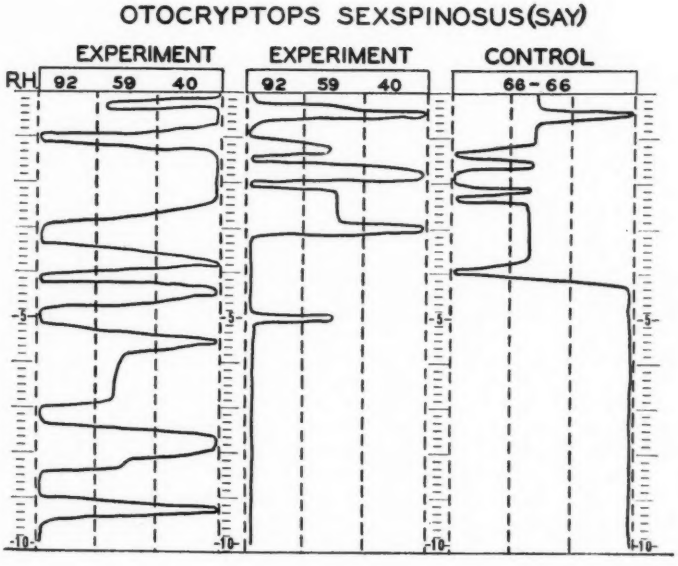


Fig. 5.—Graph showing the typical behavior pattern of *O. sexspinosus* (Say).

B. multidentatus showed little apparent selectivity for particular habitats, except that in the late winter it was found only in decaying logs. Soil collections from Trelease Woods made in the winter did not show any of this species. In the late spring and summer months these centipedes were found in many niches. For example, in logs that were in all stages of decay, in leaf duff, and in loose soil.

The largest centipede was *Otocryptops sexspinosus* (Say). It is a bright red-orange in color, with twenty-three pairs of legs, and ranges in size up to 50 mm. This species is blind, and is found in the more hidden and obscure places. The first specimens taken by the writer in the late winter were in decayed logs, or under bark. Specimens have been taken at the same time in soil collections from Trelease Woods. During the summer months the writer has found them only in the soil. In captivity they show a tendency to become sluggish and apparently indifferent to their surroundings and food. They breed and oviposit from the middle of May to July. The females exhibit a well-developed maternal instinct, staying with the eggs until they are hatched, and with the young until they are able to move freely about by themselves.

Nadabius iowensis (Meinert) is a smaller lithobiid that is fairly common. It seems to have a more cosmopolitan distribution than the other species discussed here. Specimens have been reported for various localities in Champaign County, some of them not wooded, for example, along the Illinois Central Railroad right-of-way, south of Champaign, Illinois. Other species were taken infrequently, and were not so easy to observe.

DISCUSSION

Shelford and Deere (1913) and Shelford (1914) demonstrated that certain forest animals react differentially to different rates of evaporation. Since evaporation is the product of a combination of factors including air movement, humidity, pressure, and temperature, many workers have attempted to evaluate the importance of each by various experimental approaches. Headlee (1917) indicated the effects of atmospheric humidity on insect metabolism. Park, Lockett, and Myers (1931) indicated the importance of relative humidity on the activity of nocturnal animals; and Park (1937) showed that relative humidity is one of the chief factors governing the activity of *Passalus cornutus*.

In the present study of chilopods the animals were tested in a relative humidity gradient because examination of their population numbers over a thirteen-year period indicates a positive correlation with rainfall. The humidity in the animals' natural environment is relatively high and any unusual deviation from that condition can be expected to have some demonstrable effect on the chilopod population.

The results of the gradient experiments indicate that centipedes respond positively to moisture. Although there are certain peculiarities in distribution

of the species tested, the writer concludes that the experimental data presented is not adequate to draw any conclusions in regard to population fluctuations and the factors concerned such as fecundity, survival, etc. Work along these lines is being done at the present time.

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Wildlife Effects of DDT Dust Used for Tick Control on a Texas Prairie

John L. George and William H. Stickel

U. S. Fish and Wildlife Service, Patuxent Research Refuge, Laurel, Maryland

A large scale field trial of the value of DDT in control of the Lone Star tick (*Amblyomma americanum*) was made by the U. S. Army and the U. S. Department of Agriculture in the summer of 1947. A 10 percent DDT dust mixture was applied at an average rate of 44 pounds per acre to an area of mixed tall-grass prairie and woodland in central Texas. The writers were assigned by the Fish and Wildlife Service to study the effects on birds and mammals. The experiment was of particular interest because most previous reports on the effect of DDT on wildlife have dealt with forest, agricultural, or wet areas, and with application of DDT in oil solution.

Preliminary and follow-up studies extended from June 29 to August 12, and thus included 17 days before and 24 days after dusting.

Description of Area

The test was made at Camp Bullis, Leon Springs Military Reservation, Bexar County, Texas. This locality is about 18 miles northwest of San Antonio. The camp is a 35,000 acre area situated on the Balcones Escarpment, the transitional zone between the Edwards Plateau and the Rio Grande Coastal Plain. At Camp Bullis the Escarpment consists of many barren, juniper-dotted, limestone hills interspersed with fertile valleys. There is no water on the area except for wells, a few springs, and temporary creeks.

The Salado Valley, where the test was made, has an altitude of 1100-1200 feet, with surrounding hills rising to 1300-1400 feet. The soil of the valley is a dark, heavy clay containing many fragments and outcrops of limestone.

The area had not been grazed since 1918 and consequently had more natural vegetation than the surrounding ranches. Tall-grass prairie covers 60-70 percent of the valley. The commonest grass is little bluestem (*Andropogon scoparius*). Johnson grass (*Sorghum halepense*), various genera of needle-leaved grasses, buffalo grass, and others are local or spot dominants. Scattered clumps of massed woody growth are common. The clumps usually consist of live oak, often with some hackberry and elm, and typically have dense brushy borders of several kinds of shrubs. Salado Creek is usually dry, but along its course is a continuous stand of elm, hackberry, osage orange, and other trees. In a few parts of the valley there are open, parklike stands of post oak mixed with a little black-jack oak; beneath these there is a ground cover of grass.

Dry, rocky slopes at the sides of the valley have a more xerophytic and saxicolous flora. The slopes are mostly grassy, but Texas oak, black-jack oak, and live oak are common around outcrops or in clumps. Evergreen sumac and other shrubs form thickets. Mexican juniper is common on the slopes and continues up the hillsides.

There is an abundance of grasses and forbs for grazing animals. The supply of available browse is more limited, for deer have established a well-marked browse line. The chief fruit and berry producers during the summer are the black persimmon, hackberry, and various grapes. These are not abundant and the crop is kept well harvested by wildlife. Grasshoppers and snails abound in the grasslands and are heavily utilized by wildlife. Small mammals are rare in most parts of the valley, and, in corollary, strictly predatory birds and mammals are scarce.

The Salado Valley, like most parts of the reservation, was burned over each winter prior to the war and was burned again early in 1947. The most obvious results of the burning are the removal of dead matted grass and local reduction in shrubs and small trees.

The tick problem at Camp Bullis has been described and the local vertebrates listed by Brennan (1945a and b).

DDT TREATMENT

The DDT dusting was planned and directed by Mr. J. C. Clark and Mr. Theodore H. McGregor, representing the Division of Insects Affecting Man and Animals, Bureau of Entomology and Plant Quarantine, Kerrville, Texas; and the Office of the Engineer, Fourth Army, Fort Sam Houston, Texas.

The treated plot was a 206.6 acre square, 1000 yards on a side. Dust was applied by two Niagara Dry Fog Orchard Dusters, each on a separate truck. The nozzles were moved from side to side so that each run covered a swath about 40 feet wide. Tree clumps up to 80 feet wide were circled; paths were cut through larger clumps. Dusting was done early mornings and evenings, when breeze was minimal. Four days, July 16 to July 19, were required to dust the plot.

The dust was a mixture containing one part of DDT to nine parts of pyrophyllite. The average rate of deposition, as calculated from the amount of dust used in treating the area, was 43.56 pounds of 10% DDT dust per acre. Deposition was greatest on the clumps and groves of woody vegetation where the ticks were concentrated, and least on the open prairie. Irregularity of topography and vegetation made uniform distribution difficult. As far as could be determined by observation, deposition varied from nearly zero in a few open areas to several times the average rate on some of the brushy areas.

A rain of at least one-half inch fell on the night of July 18-19 and washed a large but unknown amount of dust to the ground. The rain, coupled with irregularity of DDT deposition, makes it impossible to state the exact limits of DDT concentration that affected wildlife. Since absolute uniformity of

dusting would not be expected in any commercial or large scale DDT application, the effects observed in this trial probably provide a fair appraisal from this viewpoint. However, continued dry weather would have permitted longer exposure to greater amounts of DDT, possibly with more severe effects than those found in the present study.

BIRDS

The effect of DDT on birds was studied by two methods: (1) the bird populations of a study plot in the DDT treated area were compared before and after dusting with the population of a check plot; (2) search was made for dead or affected birds during and after the DDT treatment.

Procedure.—The DDT study plot was placed in the center of the area to be treated. The check plot was about 1.5 miles southeast of the DDT area, but was in the same valley and had nearly the same types of vegetation. Each study area was a square, 16 Gunter's chains (1056 feet) on a side, and contained 25.6 acres. Each area was staked off into 16 squares of 1.6 acres. Birds within two chains (132 feet) of the staked plot were included in the censuses, thus enlarging the effective size of the study plots to 40 acres, an area ¼ mile on a side. Both areas were studied ecologically and type mapped.

Censuses were made by walking the staked lines (264 feet apart) and plotting locations of all birds seen or heard. In the larger wooded areas the census strips were narrowed to facilitate finding and plotting the locations of birds, and smaller clumps of trees were usually circled. Each census began at dawn and lasted two hours.

Twenty systematic census trips were made from July 7-30, ten prior to dusting and ten afterwards. Censuses were alternated between DDT and check areas, so that five were taken on each area before dusting and five after dusting. Supplemental daily field work gave additional information on territories and nest sites and made it possible to determine the daily decline of bird populations in the DDT area after dusting.

The greater part of the bird census area was dusted on July 17, but the eastern 12 percent was treated on the evening of July 16 and again on the morning of July 19. July 17 has been taken as the date of application for purposes of calculation.

Results.—Tables I and II summarize the effect of the DDT on the bird populations. Some species were little affected while others were greatly reduced or eliminated. The cardinal, lark sparrow, and field sparrow were reduced from 10, 8, and 5 pairs to one pair each. The white-eyed vireo was reduced from 8 pairs to 5 pairs. There was a total loss of Bewick's wrens (3 pairs), Carolina wrens (5 pairs), Kentucky warblers (1 pair), yellow-breasted chats (3 pairs), blue grosbeaks (2 pairs), and painted buntings (4 pairs). There were no comparable losses in the check area except for lark sparrows. These

TABLE I.—Bird Densities Before and After DDT Dusting.

Species	Pairs on 40 Acre DDT Census Plot		Pairs on 40 Acre Check Plot	
	Before Dusting	After Dusting	Before Dusting	After Dusting
Turkey Vulture	×	×	×	×
Black Vulture	×	×	×	×
Cooper's Hawk	×	×	×	×
Red-tailed Hawk	×	–	×	–
Bobwhite	2 (est.)	2 (est.)	2 (est.)	2 (est.)
Turkey	×	×	×	×
Mourning Dove	4	4	6	6
Yellow-billed Cuckoo	4	2	2	2
Barn Owl	–	–	–	×
Screech Owl	×	–	–	–
Barred Owl	×	–	–	–
Nighthawk	×	×	×	×
Black-chinned Hummingbird	–	–	2	1
Golden-fronted Woodpecker	–	×	–	–
Ladder-backed Woodpecker	2 (est.)	2 (est.)	2 (est.)	2 (est.)
Scissor-tailed Flycatcher	–	1	1	1
Crested Flycatcher	1	1	1	1
Least Flycatcher	–	–	–	*
E. Wood Pewee	2	2	2	2
Purple Martin	–	×	×	×
Carolina Chickadee	3 (est.)	3 (est.)	3 (est.)	3 (est.)
Black-crested Titmouse	4 (est.)	4 (est.)	4 (est.)	4 (est.)
Bewick's Wren	3	0	3	3
Carolina Wren	5	0	8	8
Mockingbird	×	×	1	×
Eastern Bluebird	–	×	–	–
Blue-gray Gnatcatcher	–	–	–	×
White-eyed Vireo	8	5	4	4
Yellow-throated Vireo	3	2	3	3
Black and White Warbler	3	1	–	×
Kentucky Warbler	1	0	–	–
Yellow-breasted Chat	3	0	–	–
Brown-headed Cowbird	3 (est.)	F	3 (est.)	F
Summer Tanager	3 (est.)	3 (est.)	3 (est.)	3 (est.)
Cardinal	10	1	7	7
Blue Grosbeak	2	0	4	4
Painted Bunting	4	0	9	9
Arkansas Goldfinch	×	×	×	×
Lark Sparrow	8 (est.)	1	8 (est.)	4 (est.)
Rufous-crowned Sparrow	–	–	2 (est.)	1
Cassin's Sparrow	×	–	–	–
Field Sparrow	5	1	5	5
Total	83	35	85	75

(est.) Estimated number of pairs.
× Observed on the area.
– Absent.
F Fledglings only; adults had departed from the census area.
* Migrant, definitely identified. Mr. A. J. Kirn has also noted the species in the San Antonio region at this season.

declined from 8 pairs to 4 pairs in the check area, and from 8 pairs to 1 pair in the DDT area.

The birds mentioned above typically feed on the ground or at low levels. It was to be expected that they would show the greatest effect, for the DDT was directed toward the ground and bushes. Many grasshoppers and other poisoned insects were available to these birds.

TABLE II.—Time of Death of Birds in Relation to DDT Dusting.

Species	Number of Pairs Present						
	Before Dusting	Day After Dusting					
		1	2	3	4	5	6
Bewick's Wren	3	2	2	1	0	0	0
Carolina Wren	5	1	0	0	0	0	0
Kentucky Warbler	1	0	0	0	0	0	0
Yellow-breasted Chat	3	0	0	0	0	0	0
Cardinal	10	8	6	5	2	1	1
Blue Grosbeak	2	0	0	0	0	0	0
Painted Bunting	4	4	3	2	(2 ♂)	0	0
Lark Sparrow	8 (est.)	2 (est.)	2 (est.)	2 (est.)	2 (est.)	1	1
Field Sparrow	5	4	4	4	3	(3 ♂)	1
Total	41	21	17	14	9	5	3

It is more surprising that some of the insectivorous birds that generally feed at high or intermediate levels were also affected. In this group there was a decline in number of pairs of yellow-billed cuckoo from 4 to 2; black and white warbler, 3 to 1; and yellow-throated vireo, 3 to 1. These species may have done enough feeding on or near the ground to obtain DDT in lethal doses. They could also have been affected at their usual habitat level, for in some places air conditions caused heavy drifts of the dust to rise 20 or 30 feet.

The census results were confirmed in general by the birds found dead in the DDT area. Ground and brush feeders again strongly predominate: 9 cardinals, 2 painted buntings, 2 lark sparrows, 1 yellow-breasted chat, and 1 white-eyed vireo. No dead birds were found in the check area.

The nervous tremors typical of DDT poisoning were seen in two dying birds, a painted bunting and a cardinal, collected by hand on the first and fourth days after dusting.

The census data (Table II) show that diminution in numbers of the species primarily affected began the first day after dusting and continued through the fifth day. Most of the dead birds were found on the fourth and fifth days; 13 of the 15 dead birds found were discovered on or before the fifth day (Table III). Dying birds were caught on the first and fourth days. Six freshly dead birds were found on the fourth day and two on the fifth.

Three that had been dead one or more days were located the fifth day and one the sixth day. It is concluded that mortality had already begun the day after dusting and that the greater part of it had occurred before the sixth day.

TABLE III.—Birds Found Dead on the DDT Area.

Species	Day After Dusting								
	0	1	2	3	4	5	6	7	Total
White-eyed Vireo	–	–	–	–	1	–	–	–	1
Yellow-breasted Chat	–	–	–	–	–	1	–	–	1
Cardinal	–	–	–	–	6	1	2	–	9
Painted Bunting	–	1	–	–	–	1	–	–	2
Lark Sparrow	–	–	–	–	–	2	–	–	2
Total	–	1	–	–	7	5	2	–	15
Hours Spent in Searching									
Man	2	2	2	–	4.5	12.5	9	2	34
Dog	–	–	–	–	4.5	6.5	1	–	12

MAMMALS

The effect of the DDT dusting on mammals was studied by several methods: (1) Relative populations of white-tailed deer in DDT and check areas were compared by systematic road counts before and after DDT application; (2) Raccoons and other mammals were studied in DDT and check areas by box-trapping in both areas before and after dusting; (3) Limited observations of other medium-sized mammals were made in DDT and check areas in connection with box-trapping and other work in the areas; (4) Search was made for dead or affected animals during and after the DDT treatment.

It was originally intended to include in the program a quantitative study of the effect of the DDT treatment on small mammals. Preliminary trapping quickly proved that the numbers of small mammals in the DDT area were too low to make population work practical. Other workers at Camp Bullis (Brennan 1945a, p. 116), also found very few small mammals.

DEER

Procedure.—A 5.85 mile road loop was used for deer census counts from June 28 to August 1. The route crossed the DDT area in two parallel courses totalling 1.2 miles. The rest of the loop, 4.65 miles, served as a check. It traversed portions of the Salado Valley ecologically similar to the DDT area. The counts were made by two observers in a car driven at speeds of 8 to 12 miles per hour, with occasional stops for use of field glasses. Locations of deer were recorded in terms of speedometer readings estimated to the nearest

twentieth of a mile. The hour before dark was chosen for the deer counts because at that time the deer were out on the prairie feeding, where they could be seen and counted most readily.

Deer confine their day to day activities to rather restricted local areas. It is known that a considerable number of deer spent time feeding in the DDT area. It is probable, therefore, that marked toxic or repellent action of DDT would be reflected in proportionately lower counts in the DDT area than on the rest of the loop. This should be true even if no deer were restricted to the DDT area.

Results.—The numbers of deer recorded on census trips from July 6 to 27 are shown in Table IV. Counts for both the DDT area and the rest of the loop average higher after the treatment than before. Since the counts in the DDT area did not decrease after treatment, no adverse effect of the DDT on deer is demonstrated.

TABLE IV.—Numbers of Deer seen in DDT Area and Along Rest of 5.85 Mile Road Loop, July 6 to 27.

Date	DDT Area	Rest of Loop	Remarks
6	22	63	
7	29	61	
8	15	62	
9	32	70	
10	26	51	
11	9	23	Mock strafing of ground troops by bombers
12	9	54	
13	16	90	
14	19	50	
15	23	70	
16	—	—	DDT dusting. No count made
17	—	—	DDT dusting. No count made
18	—	—	DDT dusting. No count made
19	23	52	
20	35	87	
21	30	90	
22	23	79	
23	40	76	
24	32	81	
25	25	70	
26	25	69	
27	27	86	

A careful search was made for sick or dead fawns, but all deer seen in and near the DDT area seemed to be in good condition. Fawn or deer carcasses in the vicinity of the study areas would have been located because of vulture concentrations.

OTHER MAMMALS

Box-trapping was carried on over the whole treated area and in a check area of similar size. The results of this trapping are inconclusive for two reasons: (1) Raccoons and other medium sized animals ranged over areas much greater than the study plots, and many of them entered the study plots only occasionally. Consequently, few individuals were trapped often enough to provide pertinent data. (2) A striking decrease in trapping success that set in prior to the dusting made it difficult to get repeats and no doubt accounts for the apparent disappearance of certain individuals.

Raccoons were the most commonly caught animals. Thirty-six were trapped a total of 65 times. Four were taken 2-4 times in the DDT area before dusting. One of these was caught afterward. Two were trapped in the check area 2-4 times before dusting and one of them was trapped after dusting. Raccoon use of the DDT area did not decline after dusting, for there were proportionately more raccoon captures there than in the check area in comparison with the number of captures in both areas before dusting. New and repeat animals were taken in equal proportions both before and after the treatment, which does not suggest the occurrence of death and replacement. No sick or dead raccoons were seen. If any raccoon mortality took place it must have been slight, for all the data suggest that very few raccoons spent enough time in the DDT area to get much of the chemical.

Seven striped skunks were caught 18 times. One of these was caught in the DDT area both before and after dusting. The other six were caught in the check area or both in and near it. Only two of these check area skunks were seen after dusting. The reason is unknown but no effect of DDT is suggested.

Armadillos were plentiful but seldom entered traps, and no individual was trapped more than once. Repeat records were obtained by field observations of the animals. Individuals were recognized by large numerals that were painted on the rear of the shell at the time of first capture. One armadillo was recorded in the DDT area before, during, and eight days after dusting. Three other armadillos were caught in the DDT area before dusting but not afterwards, and two were taken for the first time after dusting. In the check area there were no individuals taken both before and after dusting. Four were taken before or during dusting and one was taken for the first time after the dusting. These data are too few to be conclusive but do not indicate DDT damage.

Jack rabbits and cottontails were rarely trapped. Data on their survival after the DDT treatment consist of a few field observations. A small group of cottontails was seen at a certain location in the DDT area prior to dusting. A few days after dusting a cottontail was noted at the same place. A pair of jack rabbits was observed in a particular part of the DDT area before dusting, and a pair was seen there after dusting. No rabbit remains were found in the DDT area despite much searching, use of a dog, and observation of

vulture concentrations. If the DDT produced rabbit mortality it was probably far from complete.

REPTILES

Four rough green snakes (*Opheodrys aestivus*) found dead in the DDT area after dusting were almost certainly DDT casualties. The species is insectivorous and might get DDT with its food as well as directly. One snake of this species was found crawling on the ground in an area being dusted, but escaped capture. No others were found alive either before or after the DDT treatment.

A large spiny lizard (*Sceloporus olivaceus*) was found dead in the DDT plot. No other dead lizards or snakes were found, although many probably succumbed to the DDT. Their secretive tendencies, protective coloration, and small size make it difficult to find their remains.

SUMMARY

The effect of DDT dust on wildlife was studied at Camp Bullis, Bexar County, Texas, in the summer of 1947.

Studies were made on a 206.6 acre plot that was treated with DDT for experimental control of the Lone Star tick (*Amblyomma americanum*). A dust consisting of one part of DDT to nine parts of pyrophyllite was applied at an average rate of 4.4 pounds of DDT per acre.

The limits of DDT concentration that affected wildlife cannot be stated exactly because of a heavy rain that fell near the end of the dusting, and because of irregularity in DDT deposition. Since absolute uniformity of dusting could not be expected in any large scale DDT application, the effects observed in these trials were probably fairly representative. However, continued dry weather would have permitted longer exposure to DDT, possibly with more severe effects than those found in this study.

The vegetation of the experimental area was roughly 70 percent ungrazed tall-grass prairie and 30 percent trees and shrubs.

Ground and bush feeding birds were severely affected. Cardinals, lark sparrows, field sparrows, Bewick's wrens, Carolina wrens, Kentucky warblers, yellow-breasted chats, blue grosbeaks, and painted buntings were nearly or entirely eliminated from the treated area.

Birds affected, but less drastically reduced in numbers, were yellow-billed cuckoo, black and white warbler, yellow-throated vireo, and white-eyed vireo.

Birds found dead in the DDT area were 9 cardinals, 2 painted buntings, 2 lark sparrows, 1 yellow-breasted chat, and 1 white-eyed vireo. Bird mortality had begun by the day after dusting and was largely over by the end of the fifth day.

Census of deer in DDT and check areas before and after treatment showed no reduction in deer numbers and no diminution in use of the DDT area. No deer or fawns were found dead or affected.

Box-trapping of raccoons in DDT and check areas before and after treatment showed no effects that could be attributed to DDT.

Limited observations on armadillos, striped skunks, and rabbits gave no indication of pronounced damage to these forms. No mammals of any kind were found dead or affected in or near the DDT area.

Four rough green snakes and one Texan spiny lizard were found dead in the DDT area. Mortality was probably high among insectivorous reptiles.

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The Subspecies of Tantilla gracilis

Albert J. Kirn
Somerset, Texas

W. Leslie Burger and Hobart M. Smith

Museum of Natural History
University of Illinois, Urbana

Introduction

The research upon which this analysis is based was begun by Kirn when a number of extreme color variations were noted in certain specimens of *Tantilla gracilis* from the vicinity of Somerset, Texas. An examination of specimens from throughout the range of this species by Kirn and Smith indicated that, although the color variation appeared to be without significance, variation in several other characters showed definite geographic correlation. Most of the measurements and scale counts were made by Kirn. Additional data on Oklahoma specimens was added and the final analysis was made by Burger under the direction of Smith.

Most of the statistical and graphic methods used in the following analyses are described by Simpson and Roe (1939). Sexual dimorphism in which the males exceed the females in the numerical value of a character is spoken of as positive sexual dimorphism and when the females exceed the males, as negative sexual dimorphism.

It seemed to the authors that in descriptions of geographic variation a specific reference to the distances involved preferably by a uniform method would greatly facilitate the comparison of the geographic variation in different characters and in different forms. In a single small sector of the earth's surface as the United States the convenient use of degrees of latitude and longitude for the units would introduce only slight inaccuracies. Assuming that the geographic change is uniform (which is seldom exactly the case) the shift of the mean value for each degree change in latitude or longitude, or, even better, this shift in terms of the numerical amplitude of the means involved, might serve this purpose. The use of the coefficient of divergence, which Klauber (1943) has applied so successfully to the evaluation of sexual dimorphism, is suggested for the purpose of defining geographic variation accurately. In the following pages this term is spoken of as the coefficient of sexual divergence when used to indicate the difference between the means of the two sexes, as the coefficient of racial divergence when used to indicate the difference between the means of the two subspecies, and as the coefficient of geographic divergence when used to indicate the difference between means of populations separated from each other latitudinally, or longitudinally, or both.

The abbreviated list of the locality records that follows the synopsis of each subspecies is arranged alphabetically by states and counties. A single

specimen is cited for each county from which specimens were examined, and the locality is indicated with a dot on the map. If no specimens were seen from the county a published record is referred to by author and date and a circle is used to indicate the locality on the map. All records of intergrades are allocated to the subspecies that was considered closest, morphologically when specimens were examined, or geographically when only published records were available. These records of intergrades are indicated by asterisks (*) in the lists.

This study of *Tantilla gracilis* is based on a total of 486 specimens distributed by states as follows: Texas, 239; Oklahoma, 201; Kansas, 22; Arkansas, 18; Missouri, 5; Louisiana, 1. These specimens were borrowed from the following collections:

Academy of Natural Sciences of Philadelphia (A.N.S.P.)
Collection of Alvin J. Kirn (A. J. K.)
Collection of L. M. Klauber (L. M. K.)
Collection of Ottys Sanders (O. S.)
Cornell University Museum (C. U. M.)
Department of Biology, St. Mary's University (S. M. U.)
Department of Zoology, Oklahoma A. and M. College (O. A. M. C.)
United States National Museum (U. S. N. M.)
University of Kansas Museum (K. U.)
University of Michigan Museum of Zoology (U. M. M. Z.)
University of Oklahoma Museum, Division of Zoology (U. O. M. Z.)

The specimens examined constitute only a portion of the available specimens of this species. However, the urgency of other problems necessitated the early termination of this investigation.

ACKNOWLEDGMENTS

We are much indebted to Dr. E. R. Dunn for checking types in the Academy of Natural Sciences of Philadelphia, and to Dr. Doris Cochran and Mr. Roger Conant for further checking there and at the U. S. National Museum. We are likewise indebted to Dr. E. H. Taylor for examination of and data on certain specimens in the Museum of Natural History at the University of Kansas, and for the original inspiration of this study. Many thanks are due to the officials and owners of the collections listed above for their cooperation in lending specimens to the authors.

HISTORICAL SUMMARY

Tantilla gracilis was first described by Baird and Girard in 1853 in their original description of the genus *Tantilla*. In a report on a collection of reptiles from Kansas, Hallowell (1856) called special attention to a specimen collected by Dr. Hammond which seemed to agree with Baird and Girard's descriptions except in minor details of the arrangement of the head plates and of the coloration. Cope (1860) examined the specimen and came to the conclusion that it represented a new species for which he proposed the name *Tantilla hallowelli*. When further investigation revealed similar variants in other scattered specimens of *T. gracilis*, Cope (1900) decided that *T. hallowelli* was a synonym of *T. gracilis*. In the following account it is proposed that the former name be revived for a subspecies of *Tantilla gracilis* occurring in northern Oklahoma, northern Arkansas, Kansas, and Missouri.

Burt (1936) came to the conclusion that intergradation occurred between

T. gracilis and *T. nigriceps* and consequently proposed that the latter be regarded as a subspecies of the former. As Taylor (1937) pointed out, Burt obviously overlooked the distinct difference in the coloration of the head in the two forms. In the occasional specimens of *T. gracilis* in which the head is darker than the body the dark cap is concave medially and extended laterally. In contrast, the black cap of *T. nigriceps* extends three or four scale lengths backward beyond the parietal as a more or less pointed dorsomedial extension. In other diagnostic characters there is a very slight overlap between these two species: the supralabial number of seven, characteristic of *T. nigriceps*, occurs in *T. gracilis* with an estimated frequency of 27 times per thousand specimens; and specimens of *T. nigriceps* from Texas occasionally have a total number of ventrals and caudals that falls in the range of that of the northern subspecies of *T. gracilis*. The two species appear to us to be quite distinct.

Force (1935) published a valuable local study of variation in *T. gracilis* which included a summary of the knowledge of its life history.

TANTILLA GRACILIS GRACILIS Baird and Girard

Tantilla gracilis Baird and Girard, Cat. N. Amer. Rept., pt. 1, Serpents, p. 132, 1853; Cope, Ann. Rept. Smithsonian Inst., p. 1111, 1900; Stejneger and Barbour, Check List N. Amer. Amph. Rept., ed. 5, p. 177, 1943.

Homalocranium gracile, Jan, Arch. Zool. Anat. Fis., vol. 2, p. 50, 1862; Boulenger, Cat. Snakes Brit. Mus., ed. 2, vol. 3, p. 228, 1896.

Type.—The type and paratype,[1] both formerly U. S. N. M. 4500, Indianola, Texas, are now U. M. M. Z. 3781 and A. N. S. P. 3367, respectively. The type has 128 ventrals and 43 caudals (129 and 45, respectively, in the original description), and measures 7.75 in. total length, the tail 1.58 in. (7.25 and 1.63 in the original). These apparent discrepancies, some of which may actually not exist (7.25 may well be a misprint for 7.75), are not unreasonably great.

Diagnosis.—Head usually little if any darker than the body; dark cap, when present, concave medially and extending posteriorly on the sides; supralabials 6; preoculars 1; ventrals usually 115-127 in females, 106-119 in males; caudals usually 33-41 in females, 40-50 in males; ratio of tail length to body length .160-.200 in females, .200-.235 in males.

Distribution.—North from the Rio Grande through most of the eastern two-thirds of Texas and the northwestern tip of Louisiana into southern Oklahoma and the southern half of Arkansas (Figure 1).

Locality records.—ARKANSAS: Garland (Strecker, 1924)*; Hempstead (U. M. M. Z. 84173)*; Montgomery (Burt, 1935)*; Pulaski (Dellinger and Black, 1938)*; Saline (Dellinger and Black, 1938).* LOUISIANA: Caddo (B. U. M. 3115). OKLAHOMA: Bryan (U. O. M. Z. 9911); Carter (U. O. M. Z. 519); Comanche (U. S. N. M. 7330)*; Garvin (U. O. M. Z. 5820); Latimer (U. O. M. Z. 8064);* Le Flore (U. O. M. Z. 1680)*; McCurtain (K. U. 3340); Murray (U. O. M. Z. 1407).* TEXAS:

[1] The type for this species, as for others described by Baird and Girard, was, as Dr. Dunn pointed out to us, designated in their introduction (p. viii) as "The specimen whose measurements are first given, unless stated to the contrary. . . ."

Atascosa (B. U. M. 2407); Bexar (B. U. M. 4929); Bosque (K. U. 6045); Bowie (B. U. M. 2985); Brewster (Taylor, 1937); Brown (Burt, 1936); Burnet (B. U. M. 1393); Calhoun (U. M. M. Z. 3786); Chambers (K. U.?); Comal (Burt, 1936); Cooke (U. S. N. M. 15556); Dallas (Burt, 1936); Denton (O. S. 19465); De Witt (C. U. M. 3727); Erath (Burt, 1936); Duval (U. S. N. M. 15670); Frio (B. U. M. 4869); Harrison (B. U. M. 2712); Hays (B. U. M. 4785); Kendall (Strecker, 1926d); Kerr (Burt, 1936); Liberty (Strecker, 1926b); Marion (U. M. M. Z. 78229); Maverick (U. S. N. M. 2057); McLennan (B. U. M. 4026); Medina (B. U. M. 5124); Navarro (B. U. M. 6028); Palo Pinto (C. U. M. 2292); Robertson (Burt, 1936); Runnels (Burt, 1936); San Saba (Burt, 1936); Smith (K. U. 1405); Somervell (Strecker, 1926a); Tarrant (B. U. M. 4620); Travis (C. U. M. 526); Upshur (Burt, 1936); Uvalde (C. U. M. 527); Victoria (B. U. M. 2650); Washington (A. J. K. 58); Wilson (A. J. K. 55); Wise (U. M. M. Z. 70371).

TANTILLA GRACILIS HALLOWELLI Cope

Tantilla gracilis (*nec* Baird and Girard), Hallowell, Proc. Acad. Nat. Sci. Phil., vol. 8, p. 246, 1855 (in part); Cope, Ann. Rept. Smithsonian Inst., 1898, p. 1111, 1900.
Tantilla hallowellii Cope, Proc. Acad. Nat. Sci. Phil., vol. 12, p. 77, 1860.

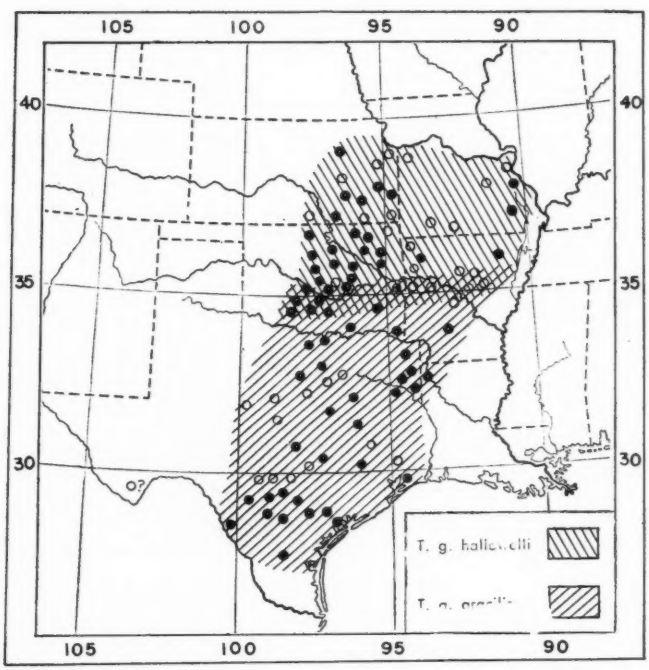

Fig. 1.—Distribution of *Tantilla gracilis*. The dots represent localities from which specimens were examined, and the circles represent published records.

Type.—A. N. S. P. 3365 is the only specimen in the collection of the Academy of Natural Sciences of Philadelphia which has the proper collection data for the holotype of *hallowelli*. This specimen agrees fairly closely with Hallowell's description of the scutellation but there is quite a discrepancy in size. Using the English units of the original description, it appears that A. N. S. P. 3365 is approximately 1⅝ inches longer, with the body 1¾ inches longer and the tail ⅛ inch shorter than the measurements given by Hallowell for the holotype. There may have been an error in the original measurements. Whatever the reason for the discrepancy we have decided to consider A. N. S. P. 3365 as the holotype. In the event that A. N. S. P.

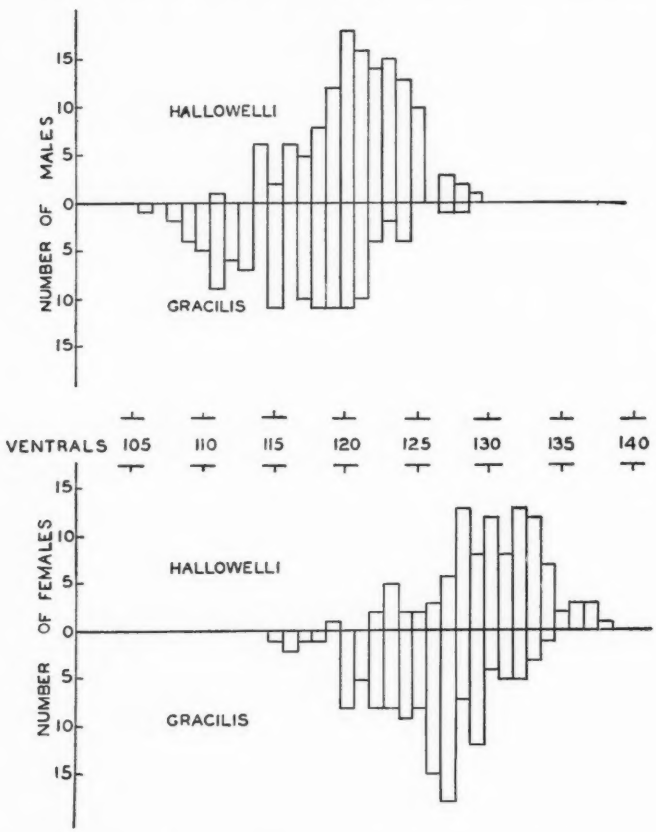

Fig. 2.—The number of ventrals in specimens of both sexes of the two recognized races of *Tantilla gracilis*.

3365 is rejected as the holotype of *hallowelli*, we hereby designate it the neotype of *hallowelli*, type locality here restricted to Manhattan, Kansas.

Diagnosis.—Similar to *T. g. gracilis* except in the following respects: ventrals 128-138 in females, 120-129 in males; caudals 42-51 in females, 51-56 in males; ratio of tail length to total length .200-.250 in females, .235-.280 in males.

Distribution.—North from southern Oklahoma and central Arkansas into eastern Kansas and Missouri south of the Missouri River (Figure 1).

Locality Records. — ARKANSAS: Benton (Dellinger and Black, 1938); Conway Schwardt, 1938)*; Faulkner (Dellinger and Black, 1938)*; Lawrence (K. U. 9535); Logan (Dellinger and Black, 1938)*; Sebastian (Dellinger and Black, 1938)*; Washington (U. S. N. M. 21217). KANSAS: Anderson (K. U. 16271); Bourbon (U. M. M. Z. 67041); Chase (Taylor, 1937); Chautauqua (Burt, 1933); Cherokee (Taylor, 1937); Cowley (K. U. 10706); Douglas (Taylor, 1937); Greenwood (K. U. 17069); Leavenworth (Taylor, 1937); Montgomery (Taylor, 1937); Pottawatomie (Burt, 1933); Sumner (Taylor, 1937); Riley (K. U. 6881); Wilson (U. M. M. Z. 67419). MISSOURI: Gasconade (U. S. N. M. 22677); Jackson (Anderson, 1942); Jefferson (C. U. M. 1433); Ozark (Hurter, 1909); St. Louis (Hurter, 1909); Stone (Hurter, 1909); Wayne (U. M. M. Z. 95288). OKLAHOMA: Caddo (U. S. N. M. 11875)*; Cleveland (U. O. M. Z. 18983)*; Craig (Burt, 1935); Creek (U. S. N. M. 94180); Hughes (U. O. M. Z. 22924)*; Kay (U. S. N. M. 90496); Lincoln (Burt, 1935); Logan (U. O. M. Z. 11023); McClain (U. O. M. Z. 19040)*; Oklahoma (U. O. M. Z. 8883); Okmulgee (U. M. M. Z. 64649); Osage (U. M. M. Z. 8197); Pawnee (U. O. M. Z. 7990); Payne (U. M. M. Z. 84023); Pottawatomie (U. O. M. Z. 9827)*; Rogers (U. M. M. Z. 81935); Seminole (U. O. M. Z. 10620); Tulsa (K. U. 10453); Washington (K. U. 10987).

VARIATION

Ventrals.—The average number of ventrals gradually increases toward the north in *Tantilla gracilis* except in southern Oklahoma and central Arkansas (the area of intergradation between *T. g. gracilis* and *T. g. hallowelli*) where the change seems to be more abrupt. As shown in Figures 2 and 5 the two subspecies show considerable overlap in the number of ventrals but the frequency distribution for the ventral numbers is such that a separation of well over 70% is obtained for the two subspecies on the basis of ventrals alone. The coefficient of racial divergence in this character is 3.8, and the coefficient of geographic divergence is .6 per degree latitude. A marked negative sexual dimorphism is also evident giving a coefficient of sexual divergence of 7.6. The coefficient of variation of the number of ventrals (the average value of the coefficients obtained for each sex of each subspecies) is $3.04 \pm .20$.

Caudals.—The variation in number of caudals is very similar to that in number of ventrals. There is a gradual increase towards the north giving a coefficient of racial divergence of 8.7 and a coefficient of geographic divergence of 1.4. These figures indicate greater differences in the number of caudals than in ventrals in relation to the mean value involved. Since the actual differences in the mean number of caudals are much less than those in the mean numbers of ventrals the separation of *T. g. gracilis* and *T. g. hallowelli* on the basis of the number of caudals is not as complete as that obtained with ventrals. However the separation of subspecies on the basis of

the number of caudals also exceeds the 70% margin. There is a positive sexual dimorphism giving a coefficient of sexual divergence of 12.7. The coefficient of variation of the number of caudals (the average value of the coefficients obtained for each sex of each subspecies) is 6.02±.47.

Relative tail length.—The variation in ratio of the tail length to the total length parallels in a general way that of the number of caudals. There is an increase in the relative tail length toward the north with a coefficient of racial divergence of 5.6 and a coefficient of geographic divergence of .93 per degree

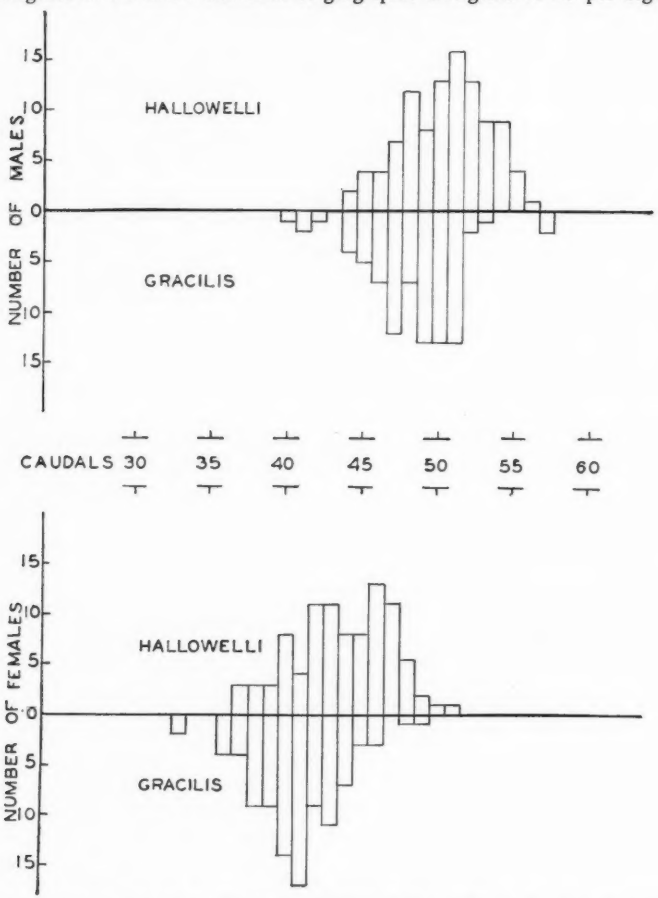

Fig. 3.—The number of caudals in specimens of both sexes of the two recognized races of *Tantilla gracilis*.

latitude. This character also exhibits a positive sexual dimorphism with a coefficient of sexual divergence of 17.0. The coefficient of variation of the caudals (the average values obtained for each sex of each subspecies) is $7.97 \pm .63$. Because of the relatively great individual variation the separation of the two races of *Tantilla gracilis* on the basis of this character falls slightly below 70%. However this character adds considerable support to the other two characters that define *T. g. gracilis* and *T. g. hallowelli*.

It is interesting to compare the mean values obtained in this study for

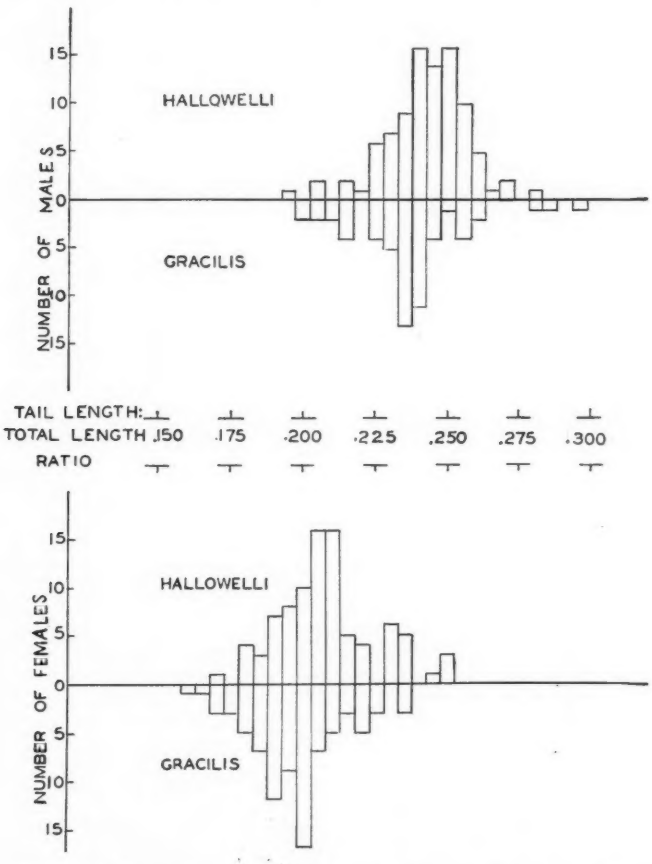

Fig. 4.—The relative tail length in specimens of both sexes of the two recognized races of *Tantilla gracilis*.

the three preceding characters in *T. g. hallowelli* to those calculated from the data presented by Force (1935) for a large sample of specimens from northern Oklahoma and central Arkansas. As shown in Table 2 Force's figures for the ventrals agree fairly well with those obtained in this investigation. How-

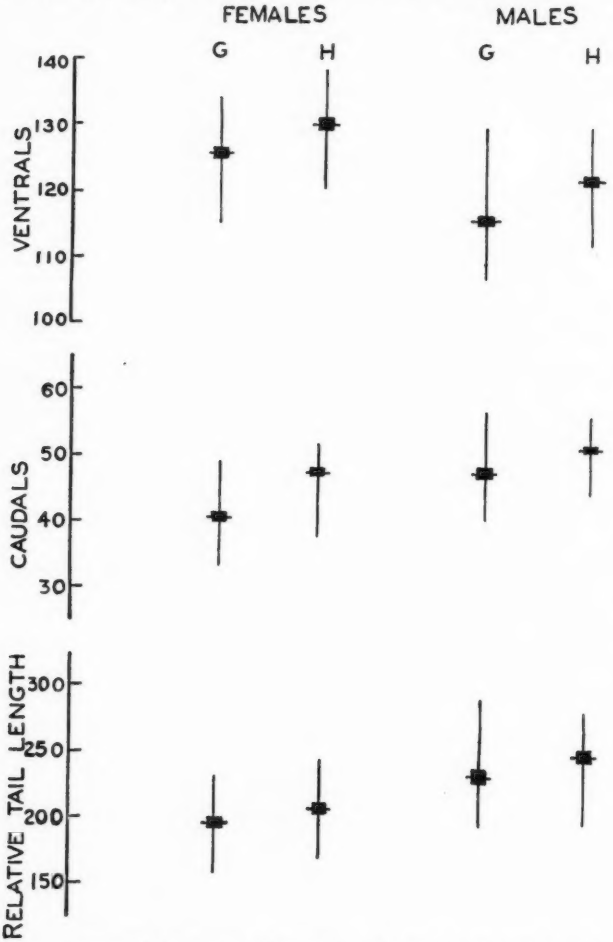

Fig. 5.—Contrast of the number of ventrals, of the number of caudals, and of the relative tail length in both sexes of *T. g. gracilis* (G) and *T. g. hallowelli* (H). The vertical lines represent the observed ranges, and the black rectangles represent the distance from $(M + 2\sigma m)$ to $(M - 2\sigma m)$ with a crossline at M. If these rectangles do not overlap it can be assumed that the means differ significantly.

TABLE 1.—Ventrals, caudals, and relative tail length in *Tantilla gracilis gracilis* and *Tantilla gracilis hallowelli*.

Character	T. g. hallowelli	T. g. gracilis
Ventrals		
Males		
Average	121.22 ± .29	115.97 ± .36
Range	111 – 129	106 – 128
No. of specimens	134	120
Females		
Average	130.07 ± .37	125.67 ± .36
Range	119 – 138	115 – 134
No. of specimens	103	122
Caudals		
Males		
Average	51.67 ± .27	47.75 ± .29
Range	44 – 56	40 – 57
No. of specimens	102	102
Females		
Average	46.79 ± .16	40.99 ± .28
Range	37 – 51	36 – 49
No. of specimens	93	92
Ratio of tail length to total length		
Males		
Average	.2477 ± .0016	.2336 ± .0022
Range	.195 – .280	.200 – .295
No. of specimens	93	67
Females		
Average	.2084 ± .0018	.1976 ± .0017
Range	.170 – .250	.160 – .235
No. of specimens	93	84

TABLE 2.—Comparison of the average values for three taxonomic characters calculated from the data of Force (1935) and calculated in the present study.

Character	Sex	Mean from present study	Means from data of Force
Ventrals	male	130.07	131.57
Ventrals	female	121.22	122.38
Caudals	male	46.79	33.61
Caudals	female	51.67	39.99
Ratio of tail length to total length	male	.2084	.2053
Ratio of tail length to total length	female	.2477	.2349

ever her figures for the number of caudals and for the relative tail length are much lower than the present figures. This discrepancy may possibly be due to inclusion of specimens with incomplete tails in Force's data.

Supralabials.—There are apparently no racial, geographic, or sexual differences in the number of supralabials of *Tantilla gracilis*. As shown in Table 3 variations from the normal number of 6 are relatively infrequent. The coefficient of variation for this character is 4.04±.10.

TABLE 3.—Frequency of the numbers of supralabials in *Tantilla gracilis*.

Number	Frequency
4	2
5	10
6	758
7	21
8	2

Infralabials.—Variation in the number of infralabials from the usual number, 6, is even less frequent than that in the supralabials (see Table 4). The coefficient of variation in the number of infralabials is 2.83±.07. The skewness of the distribution of the numbers of both series of labials (shown in a preponderance of increases in number of supralabials and of decreases in number of infralabials) is apparently not statistically significant.

TABLE 4.—Frequency of the numbers of infralabials in *Tantilla gracilis*.

Number	Frequency
4	1
5	18
6	770
7	4
8	0

Preoculars.—The preocular number of 1 is practically constant. The three increases and 3 decreases shown in Table 5 give a coefficient of variation of 8.70±.22.

TABLE 5.—Frequency of the number of preoculars in *Tantilla gracilis*.

Number	Frequency
0	3
1	787
2	3

Postoculars.—Only two variations from the postocular number of 1 were noted, as recorded in Table 6. The coefficient of variation is 1.57±.04.

TABLE 6.—Frequency of the numbers of postoculars in *Tantilla gracilis*.

Number	Frequency
1	791
2	2

Anals.—A single anal occurs in *Tantilla gracilis* with a frequency of about .013. This gives a coefficient of variation from the normal number, 2, of $5.60 \pm .14$.

TABLE 7.—Frequency of the numbers of anals in *Tantilla gracilis*.

Number	Frequency
1	10
2	783

Coloration.—Tantilla gracilis is rather variable in coloration, but the variation seems to have no racial or geographic significance. At this particular time no live specimens are available for accurate color description. In general terms, the dorsal coloration of live specimens varies from gray-brown to rich red-brown with the head slightly darker. The ventral coloration is usually white on the anterior part of the body deepening posteriorly to salmon pink except along the ends of the ventrals, which are white. The head is usually only slightly darker than the body, but specimens in which there is a distinct black cap seem to occur throughout the range. The posterior edge of the dark cap is usually extended backward on the sides and is cleft medially. In some specimens the several dorsal scales bordering the parietals and temporals posteriorly are slightly lighter than the other dorsal scales giving the appearance of an indistinct neck band.

The following description applies to a specimen of *T. g. gracilis* from Somerset, Atascosa County, Texas, which had a distinct dark cap: black cap extending anteriorly to the middle of the prefrontals and including the upper half of the first three supralabials; lateral border curving slightly dorsad along the lower posterior border of the eye cutting across the top of the sixth supralabial onto the anterior temporal and slightly ventrad to a point just above the corner of the mouth where the border curves dorsad along the third dorsal scale row and extends to a point two scale rows posterior to the parietal; posterior border truncate but cleft medially to the point of junction of the parietal; black cap thus heart-shaped when seen from above, bean-shaped when seen from the side.

This black cap, which seems so distinct from the typical condition, is ap-

parently of no significance, since specimens so marked have been found to appear occasionally in company with specimens of normal color in scattered localities in the ranges of both subspecies of *Tantilla gracilis*. Furthermore this feature occurs in different degrees of distinctness ranging from a slight darkening of the head to the extreme described above. Even in the extreme condition the black cap is apparently uncorrelated with any other difference.

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An Extreme Case of Malocclusion in the Muskrat

Maurice M. Alexander
Department of Forest Zoology, New York State College of Forestry, Syracuse

Herbert L. Dozier
U. S. Fur Animal Field Station, Cambridge, Maryland

During the course of studies on the muskrat (*Ondatra z. zibethicus*), being currently conducted on the Montezuma National Wildlife Refuge, Seneca Falls, New York (the area described by Dozier, 1945), an extreme case of malocclusion was discovered by the writers on March 19, 1948. The affected animal, trapped by Edward W. Lawson in cat-tail formation, was a 1 pound 11 ounce subadult female that measured as follows: total length 22⅛ inches; tail, 9⅝ inches; and hind foot, 3¼ inches. Although some of the older trappers of the region state that they have occasionally encountered malocclusion in muskrats such cases can be considered as very rare.

Malocclusion has been reported as occurring in several of the rodents and closely related groups. Some of these reports show or describe incisors as curling and piercing the skull, usually the maxilla, but in most instances these reports have been based on moderate cases of malocclusion. In comparison, our specimen represents an extreme case inasmuch as the right upper incisor had retained its entire life growth, completing 1 1/3 turns and measuring 80 mm. in length. The left upper incisor is turned to the left slightly more than the right one so that contact is not made in any manner with the lower incisors. This tooth has been broken off, with the curl only ½ a turn and measuring 46 mm. in length. The lower incisors appear normal, measuring 14 mm. (right) and 16 mm. (left) respectively in length. Although one of the lower molars is slightly twisted, the molar occlusion is good. Both lower incisors come in contact with the right upper incisor and have worn off the yellow pigmentation of the anterior surface so that a narrow white area shows along its length (see Figure 1). The circling of this incisor crowded the right maxilla and as a result removed part of it. A heavily worn area is present at a distance of 20 mm. from the tip, evidently where the growth of the tooth was slow and the occlusion was better than at a later time. The fact that the initial point of the tooth is present, however, demonstrates that the condition had existed since birth.

Further examination of the skull shows no evidence of any bone deformities due to physical accident or disease. Dozier (1943) found cases in Maryland muskrats where large abscesses were present under the jaws, with an associated spongy malformation of the jaw itself which was called "lumpy jaw." Malocclusion resulted from this disease of the jaw bone but in the case of the Montezuma specimen, the jaws are normal in structure and appearance.

In a recent article Quortrup (1948) explains that the occurrence of dental deformities, including malocclusion, is rather common at some of the chinchilla

farms of the country. Here the deformities might have a genetic or nutritional origin. Templeton, (1944) in his studies of dental deformities in domesticated rabbits, attributes "buck teeth" malocclusion to hereditary origin.

The uncontrolled growth of the upper incisors of the specimen in question is the result of their setting in the maxilla at a slight angle to the left. The cause is unknown but the condition apparently has existed since birth. This prevented the simultaneous wearing away of the teeth at an equal rate to that of their growth, as is the case in normal individuals.

That incisor growth is considerable has been shown by Shadle and coworkers (Shadle, 1936; Shadle, Wagner and Jacobs, 1936; Shadle, Valvo and Eckert, 1938) who found that the Norway rat (*Rattus norvegicus*) has a total yearly incisor extrusion of 20.5 inches; the guinea pig (*Cavia cobaya*) female, 15.5 inches and male, 18 inches; and the domestic rabbit, 18 inches. All show greater growth in the lower incisors than in the upper ones. Although the 40 per cent increase in growth of the lower incisors over the upper ends of the Norway rat need not hold for the muskrat, some possibilities can be stated. Based on the 80 mm. or 3.15 inches of growth in the right upper in-

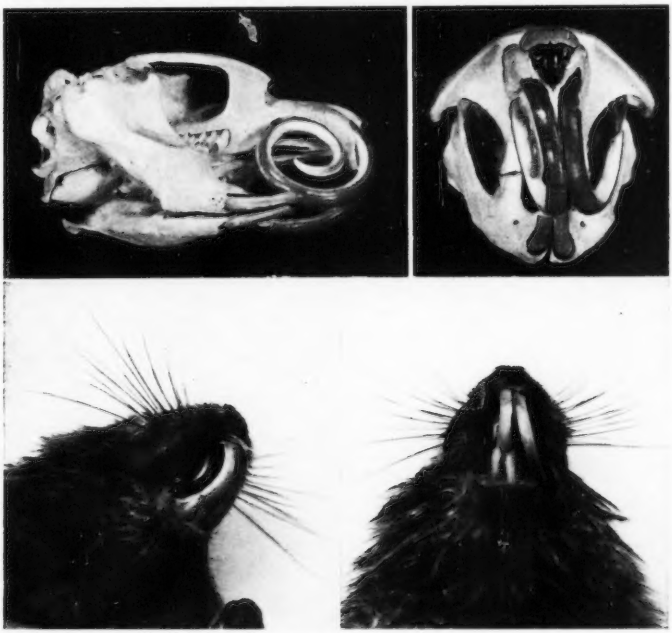

Fig. 1.—Upper. Skull cleaned to show the curled and twisted upper incisors (reduced one-fifth). Lower. Subadult female muskrat showing extreme malocclusion (reduced approx. one-half).

cisor and allowing for 40 per cent greater extrusion, the lower incisors would measure approximately 4.4 inches. This would give a total length of extrusion for the 4 incisors of 12.1 inches which when compared to 20.5 inches for the Norway rat would mean that this individual muskrat would be approximately 7 months old. Since the animal was trapped on March 19, one can estimate that it was born about the middle of August. Although there was no deposition of fat in the superficial fascia, emaciation appeared to be very slight. Due to the severe malnutrition and reduced growth resulting therefrom, one would suspect that birth actually occurred at an earlier date, certainly within the breeding season preceding capture. The large size of the hind foot would also indicate that it was approaching the adult stage.

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BOOK REVIEWS

BIOLOGY: ITS HUMAN IMPLICATIONS. By Garrett Hardin. W. H. Freeman and Company, San Francisco, Calif. 1949. 635 pp., illus. $5.00.

"In this uncertain world, the only honest glory we may hope to gain is that which may be ours if we attack our problems with clarity and high spirit." This is the concluding sentence of Hardin's *Biology: Its Human Implications*, the first in a series of new biology textbooks being published by W. H. Freeman and Company. Hardin has attacked his problem with clarity and with omnipresent high spirit. His book will be read with pleasure and interest even by those who do not base their courses on it.

The problem is a severe one: "What should a student learn in a college course in biology if he will never again be exposed to formal instruction in the subject?" The problem is scarcely less severe if further instruction does follow. Hardin has faced this primary and today ubiquitous problem with zest and has provided his own approach to a solution, one which by no means precludes the use of the book in courses which are also the foundation for further study.

To the author, biology is no mere apposition of the separate sciences dealing with plants and animals. It is integrated in the central fact of human life, in principles of general application throughout the range of living things, and in the relationships among organisms. The book opens with two introductory chapters which contain fresh and honest discussions of such questions as: What is science? What is an experiment? What is life? Next follow thirteen chapters devoted to the structure and function of man ("The Measure of Man"); eight chapters which deal mainly with other kinds of animals and with plants, but contain much appropriately placed material of general interest ("The Variety of Living Things"); eight chapters on the cell, cell physiology, the gene, sex, the nature of antibodies, and morphogenesis ("The Unity of Living Things"); and a final group of nine chapters concerned with ecological relationships, evolution, and eugenical problems ("The Web of Life"). All told, there are forty chapters, many of them refreshingly short and with abundant new illustrations. Questions and problems conclude most of the chapters, together with a list of selected references. The paper and typography are excellent.

A great many of the abundant facts of biological science are incorporated in this book, but they often appear incidentally and in novel settings rather than as cold, separate chapters denoted by subject matter labels. For instance, a brief treatment of taxonomy occurs as the first section of a chapter on the lower invertebrates; instinctive behavior is discussed in connection with insects; chapter 19 "What Is a Plant?" includes a discussion of the use of tracer isotopes; chromosomes, haploidy, and diploidy first appear in chapter 21 "Mosses and Ferns"; and so on. While no two biologists would ever agree as to the space and emphasis to be given to any particular topic, the reviewer believes that Hardin has been remarkably successful in rearranging and integrating his material.

Certain general features of this book are outstanding. The author writes informally, often asking questions of himself and the reader and creating the impression that we are all united in wanting to know the answers, partial as they may be. It is clear that he understands many of the things which it is difficult for students to grasp or visualize. The illustrations are for the most part original drawings by Evan L. Gillespie, and are admirably adapted to the tone and content of the text. Unusual attention is paid to exhibiting the method whereby experimental biological science has advanced. This is done not through the study of history but through examination of the logical and operational processes involved in experimentation. Rightly or wrongly, the author made up his mind at the outset that historical treatment would be minimized, a decision which results, for instance, in the forthright appearance of the gene as a "hypothetical self-reproducing producer of an enzyme," whose activities we are introduced to *via* the nutrition of *Neurospora*.

To the reviewer the parts of this book which might prove to be least successful on the educational firing line are the ones devoted to the development of genetic and evolutionary

theory. The author has dropped out Weismann, Morgan, and Mendel (none of whom appear even in the index), and given us at the outset biochemical genetics and the Hardy-Weinberg law. Since enzymes, amino acids, and vitamins are already somewhat shadowy entities for most beginning students of biology, the reviewer would fear lest the gene emerge from this treatment either as a shadow of a shadow or as a *deus ex machina*. Admittedly, the problem of the extent to which students with little chemistry can appreciate modern developments in biochemistry and genetics becomes ever greater. Hardin is to be praised for his confidence and courage in facing this growing challenge, and in producing a modern synthesis of aspects of biological science which unquestionably have deep human implications. If anything resembling a unified science of life is to appear in our collegiate curriculum, this book points both the way and some of the difficulties which attend it. —EDWARD S. CASTLE, Harvard University, Cambridge, Mass.

A STUDY OF PALAEOZOIC ARACHNIDA. By Alexander Petrunkevitch. Transactions of The Connecticut Academy of Arts and Sciences. Vol. 37, pp. 69-315, January 1949.

The present work is the latest and most comprehensive contribution to our knowledge of the evolution of the Arachnida that has been made by Dr. Petrunkevitch. His first paper on the subject, *A Monograph of the Terrestrial Palaeozoic Arachnida of North America,* appeared in 1913 and since then there have been many advances in our knowledge of both recent and fossil spider-like animals. There have also been great improvements in the techniques of preparing fossils for study.

This new investigation is based on all specimens held by American museums, together with the large collection of the British Museum. A restudy of all this material has enabled the author to correct many errors of observation and interpretation which have crept into the literature and also to develop a new concept of the relationships of the 16 orders of the Class Arachnida. Eighty-three plates and a bibliography of 165 titles add much to the text.

Among its more important contributions, Dr. Petrunkevitch's book discusses the external and internal structure of Palaeozoic Arachnida on the basis of new evidence. It establishes the identity of the first abdominal segment for five orders. It describes sexual characters in the Anthracomarti. It discusses the true nature of the Silurian scorpions and proposes a new classification of the Palaeozoic scorpions.

It divides the Class Arachnida into four subclasses. The subclass Latigastra are those forms in which the cephalothorax and abdomen are joined across their entire width and which have the coxae of the chelicerae above and not between the coxae of the pedipalps. The mouth is in front of or between the pedipalpal coxae. To this subclass belong the five orders Scorpiones, Pseudoscorpiones, Opiliones, Architarbi (extinct) and Acari. The subclass Stethostomata agrees with the Latigastra in having a broad juncture of the cephalothorax and abdomen but differs in the position of the coxae of the chelicerae and the mouth. The location of the cheliceral coxae between the coxae of the pedipalps has forced the mouth backward to a position between the coxae of the first pair of legs. In this arrangement of the coxae, the subclass recalls the classes Xiphosura and Eurypterida. Here are included two orders, both extinct, the Haptopoda and Anthracomarti. The third subclass contains only the single extinct order Trigonotarbi and has been named Soluta in reference to the lack of stability of certain characters within the order. The final subclass, the Caulogastra, includes all arachnids with petiolate abdomen. Five branches comprising eight orders are recognized, only one of which has become extinct. These are the Latisterna, with the single order Palpigradi, the Camarostomata, with the three orders Schizomida, Thelyphonida and Kustarachnae. the Labellata with the two orders Phrynichida and Araneae, the Cucullifera and the Rostrata for the orders Ricinulei and Solifugae respectively.

Those interested in the study of evolutionary trends will find much of interest in Dr. Petrunkevitch's analysis of the Arachnida.—E. A. CHAPIN, U. S. National Museum, Washington, D. C.